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SERIALS

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Alabama, Geological Survey, Information Series. University, Alabama.
Alaska, University, Geophysical Institute, Contributions. College, Alaska.
American Association of Petroleum Geologists, Bulletin. Tulsa, Oklahoma.
American Ceramic Society, Journal. Easton, Pennsylvania.
American Journal of Science. New Haven, Connecticut.
American Mineralogist (Mineralogical Society of America). Ann Arbor, Michigan.
American Society of Civil Engineers, Irrigation and Drainage Division, Journal. New York.
American Society of Civil Engineers, Soil Mechanics and Foundations Division, Journal. New York.
Analytical Chemistry. Easton, Pennsylvania.
Better Roads. Chicago.
Brigham Young University, Dept. of Geology, Brigham Young University Research Studies, Geology Series. Provo, Utah.
California, Division of Mines, Mineral Information Service; Special Report. San Francisco.
California, University, Publications in Geological Sciences. Berkeley and Los Angeles.
Canada, Directorate of Scientific Information Service, Defence Research Board, [Translations]. Ottawa.
Canada, Geological Survey, Memoir. Ottawa.
Canadian Journal of Physics (National Research Council of Canada). Ottawa.
Canadian Mining and Metallurgical Bulletin. Montreal.
Chicago, Natural History Museum, Fieldiana: Geology.
Economic Geology (Society of Economic Geologists). Lancaster, Pennsylvania.
Emory University Quarterly. Atlanta, Georgia.
Evolution (Society for the Study of Evolution). Lancaster, Pennsylvania.
Field and Laboratory. Dallas, Texas.
Florida Geological Survey, Information Circular. Tallahassee, Florida.
Geological Society of America, Bulletin. New York.
Geophysics (Society of Exploration Geophysicists). Tulsa, Oklahoma.
GeoTimes (American Geological Institute). Washington, D. C.
Harvard University, Museum of Comparative Zoology, Bulletin. Cambridge, Massachusetts.
Idaho, Bureau of Mines and Geology, Information Circular. Moscow, Idaho.
Illinois State Academy of Science, Transactions. Springfield, Illinois.
Illinois State Geological Survey, Bulletin; Circular. Urbana, Illinois.
International Geology Review (American Geological Institute). Washington, D. C.
Journal of Geology. Chicago.
Journal of Geophysical Research. Washington, D. C.
Journal of Paleontology. Tulsa, Oklahoma.
Journal of Sedimentary Petrology. Tulsa, Oklahoma.
Kansas, University, Museum of Natural History, Publications. Lawrence, Kansas.
Kansas, University, Paleontological Contributions. Lawrence, Kansas.
Michigan Mineralogical Society, Publication. [Bloomfield, Michigan?].
Mining Engineering (American Institute of Mining, Metallurgical and Petroleum Engineers). New York.
Mississippi State Geological Survey, Bulletin. University, Mississippi.
National Academy of Sciences-National Research Council, Publication. Washington, D. C.
National Research Council, Highway Research Board, Bulletin. Washington, D. C.
Nautilus. Philadelphia, Pennsylvania.
Oil and Gas Journal. Tulsa, Oklahoma.
Oklahoma Geological Survey, Bulletin; Circular. Norman, Oklahoma.
Petroleum Week. New York.
Saskatchewan, Dept. of Mineral Resources, Report. Regina, Saskatchewan.
Science. Washington, D. C.
Shale Shaker (Oklahoma City Geological Society). Oklahoma City, Oklahoma.
South Carolina, State Development Board, Division of Geology, Geologic Notes. Columbia, South Carolina.
U. S. Atomic Energy Commission, [Publication]. Oak Ridge, Tennessee.
U. S. Geological Survey, Bulletin; Coal Investigations Map; Geologic Quadrangle Map; Miscellaneous Investigations Map; Oil and Gas Investigations Map; Professional Paper; Reports, Open-File Series. Washington, D. C.
U. S. Waterways Experiment Station, Vicksburg, Miss., Technical Report.

INDEX TO VOLUME I

The subject and author indexes to Volume I of GeoScience Abstracts are now being assembled. They will be published as a separate and sent to all subscribers to Volume I in April 1960.

GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

529. Thom, W.T., Jr. TECTONIC SKETCH AP OF NORTH AMERICA, SHOWING REGIONAL RUCTURAL FEATURES AND APPROXIMATE NFIGURATION OF SURFACE OF BASEMENT MPLEX: scale 1:10,000,000, Red Lodge, Montana, llowstone-Bighorn Research Association, Inc., 59.

The "surface of the basement complex," as here fined, corresponds chiefly to the sub-Beltian or b-Cambrian surfaces. However, where the Paleo- ic sediments have been strongly metamorphosed, ese, too, are regarded as belonging to the "base- ent complex." Many features are depicted schemat- ally.--Auth.

An index map shows relation of Williston Basin to darby tectonic provinces.

530. Hallgarth, Walter E. STRATIGRAPHY OF ALEOZOIC ROCKS IN NORTHWESTERN COLORA- D: U.S. Geol. Survey, Oil & Gas Inv. Map OC-59, 59, pub. 1960.

The chart shows the thickness, lithology, facies anges, fossils, and stratigraphic correlation of rmations as derived from a study of outcrop sam- es and well samples and cores taken from key oil d gas wells drilled around the northern and western anks of the Piceance Creek basin. An index map ows the geographic location of outcrop sections and ells used in compiling the chart. A text briefly escribes stratigraphy and oil and gas possibilities. U.S. Geol. Survey.

531. Gates, R.M. BEDROCK GEOLOGY OF THE OXBURY QUADRANGLE, CONNECTICUT: U.S. Geol. urvey, Geol. Quad. Map GQ-121, scale 1:24,000, ontour interval 10 ft., lat. 41°30'-41°37'30"N., ng. 73°15'-73°22'30"W., 1959, pub. 1960.

The Roxbury quadrangle lies in the western Con- ecticut highlands, a southern extension of the Green ountain plateau. The major bedrock units are the artland formation [Lower Cambrian(?)], the Mine ill granite gneiss, the Mount Tom hornblende neiss, and the Nonewaug granite [Paleozoic]. The ranite gneiss and hornblende gneiss are intrusives. he granite gneiss forms the core of a foliation dome n the Hartland. The structure, petrology, and met- morphism of these units are discussed.--U. S. Geol. urvey.

532. Kottlowski, Frank E. GEOLOGY AND COAL EPOSITS OF THE COAL CITY QUADRANGLE, REENE, CLAY, AND OWEN COUNTIES, INDIANA: .S. Geol. Survey, Coal Inv. Map C-28, scale :24,000, contour interval 10 ft., lat. 39°07'30"- 9°15'N., long. 87°-87°07'30"W., 1959, pub. 1960.

This map covers 58 sq. mi. in southwestern ndiana and shows the extent and distribution of bed- ock and unconsolidated surficial deposits, distribu- on, structure, and mined areas of coal. Tables ontain data on underground mines, coal reserves, nalyses of coal samples, and oil and gas drill holes, nd on thickness and elevation of coal beds and thick- ess of surficial deposits based upon refraction eismic studies. An explanatory text is included.-- . S. Geol. Survey.

2-533. Bramkamp, R.A., and Leon F. Ramirez. GEOLOGY OF THE WADI AL BATIN QUADRANGLE, KINGDOM OF SAUDI ARABIA: U.S. Geol. Survey, Misc. Inv. Map 1-203 A, scale 1:500,000, 1959, pub. 1960.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Stratigraphy 2-570; Mineral Deposits 2-730; Fuels 2-759, 2-760.

2-534. Cheesman, R.L. THE GEOLOGY OF THE WAPUS BAY AREA (WEST HALF): Saskatchewan, Dept. Mineral Resources, Rept. no. 35, 22 p., col. geol. map scale 1 in. to 1 mi., 1959, 14 refs.

The map area (56°30'-56°45' N. 102°15'-102°30' W.) is underlain by an intricately folded assemblage of Precambrian metasedimentary gneisses and granulites associated with calc-silicate and hornblendic gneisses. The metasedimentary rocks are intruded and replaced by granodiorite, quartz diorite, and pegmatite which are considered to be the youngest rocks in the area. In the northern part of the area lenses and sill-like bodies of amphibolite and hornblende diorite are abundant and probably represent metamorphosed early basic and ultrabasic intrusions.

Two main occurrences of uraninite mineralization in pegmatite are described, and a molybdenite showing and a base metal find are briefly mentioned.--L. S. Beck.

2-535. Kirkland, S.J.T. THE GEOLOGY OF THE BRABANT LAKE AREA, SASKATCHEWAN: Saskatchewan, Dept. Mineral Resources, Rept. no. 33, 33 p., col. geol. map (in pocket), scale 1 in. to 1/2 mi., 1959, 7 refs.

The map-area lies between 56°-56°08'N. 103°40'-104°W. All the consolidated rocks are Precambrian. They consist mainly of NE.-trending garnetiferous biotite migmatite and biotite gneisses, associated with hornblende and calc-silicate gneisses. The NW. part of the area is underlain by a NE.-trending mass of biotite granodiorite, and in the extreme NW. hornblende granodiorite and quartz diorite form a large intrusive mass.

Two main types of mineralization occur in the area: pyrrhotite-pyrite mineralization and sphalerite-chalcopyrite mineralization. The iron sulfides are considered to be syngenetic and the occurrences examined are of no economic significance. The main Cu-Zn deposit is described, and a working hypothesis is presented for this type of mineralization in the area. It is suggested that it is a result of metamorphic mobilization and transportation of material from original sediments that are now represented by "Kisseynew-type" garnet biotite migmatite and interlayered calc-silicate and hornblende gneisses. Mobilized material formed pegmatite bodies within the garnetiferous migmatite, but the bulk of the components forming the sulfide minerals were deposited along a metamorphic front in suitable structural environments. It is therefore considered that the most favorable environment for possible base metal mineralization is in the vicinity of structural warps along the general contact zone between the garnetiferous migmatite and biotite gneiss.--L. S. Beck.

2-536. Pearson, W.J., and E. Froese. THE GEOLOGY OF THE FORBES LAKE AREA, SAS-

KATCHEWAN: Saskatchewan, Dept. Mineral Resources, Rept. no. 34, 28 p., col. geol. map scale 1 in. to 1 mi., 1959, 8 refs.

The map-area (55°45'-56°N., 104°30'-105°W.) is underlain by an apparently conformable sequence of NE.-trending metamorphosed sedimentary and volcanic rocks intruded by stocks and sill-like bodies of granitic intrusive rocks. A large mass of granitic intrusive rocks occupies the NW. part of the map-area. Smaller bodies of diorite, metagabbro, and metapyroxenite form mappable units. From 1/2 to 1/3 of all the rocks in the area are intrusive.

Disseminated pyrrhotite, in amounts up to 5% of the rock, is common in many parts of the area especially in a NE.-trending central zone of the eastern half of the area. This central zone, which is about 2 mi. wide, consists of hornblende and calc-silicate gneisses interlayered with biotite meta-sedimentary rocks. Within this zone massive pyrrhotite occurs closely associated with pronounced shearing and, in places, minor folding. Minor amounts of chalcopyrite observed in places are considered to be later than the pyrrhotite.

Several occurrences of pyrite-chalcopyrite mineralization are described from the volcanic rocks in the SE. part of the area.--L. S. Beck.

2-537. Geological Society of Sacramento. ANNUAL FIELD TRIP...MAY 2 AND 3, 1959. COAST RANGES, LIVERMORE VALLEY TO HOLLISTER AREA: 19 p., 3 geol. maps (in pocket), secs. (in pocket), [Sacramento, California, 1959], 10 refs.

The text includes route logs for Trip I (Altamont Pass-Livermore Valley-Calaveras fault zone) and Trip II (Hollister area) and a table of geologic units and thicknesses.

2-538. Oakeshott, Gordon B. GEOLOGIC SKETCH OF THE SOUTHERN COAST RANGES: California, Div. Mines, Mineral Inf. Service, v. 13, no. 1, p. 1-13, illus., Jan. 1960, 20 refs.

The California Division of Mines has recently published the Santa Cruz, San Luis Obispo, and Santa Maria sheets of the new colored 1:250,000-scale state geologic map. These sheets encompass the greater part of the southern Coast Ranges which extend from the latitude of San Francisco to the Santa Ynez Mountains in Santa Barbara County.

The oldest rocks consist of metavolcanic and metasedimentary rocks of the Sur series of pre-Upper Jurassic age which have been intruded by granitic rocks of Cretaceous age. The Upper Jurassic-Cretaceous Franciscan-Knoxville group and about 30,000 ft. of marine Upper Cretaceous sandstone and shale are the most widely distributed formations. They are overlain by marine sedimentary formations of Paleocene to Pliocene age, of which the Miocene Monterey formation is most widely distributed. Loosely consolidated land-laid beds of the Plio-Pleistocene Paso Robles formation unconformably overlie the older formations in the larger basins.

Structural grain of the southern Coast Ranges is NW., with the present coastline having a somewhat more northerly trend than the axes of the major structures. A succession of epics of crustal deformation culminated in the latest and greatest orogeny which was initiated in late Pliocene time. Fault movements have continued into modern time along the San Andreas and associated great fault zones.

Geologic structures and formations are described along U. S. Highway 101 from Gilroy to Buellton, particularly as exposed in road cuts across the Sant Cruz Mountains and Santa Lucia Range, and along State Highway 1 from Santa Cruz to San Luis Obispo

Principal mineral deposits of the southern Coast Ranges are petroleum, the raw materials used in cement, rock products, diatomite, Hg, and chromite. San Ardo, in the southern Salinas Valley, is one of the largest heavy-oil fields in the world.--Auth.

2-539. Smith, J. Fred, Jr., Irving J. Witkind, and Donald E. Trimble. GEOLOGY OF THE LOWER MARIAS RIVER AREA, CHOUTEAU, HILL, AND LIBERTY COUNTIES, MONTANA: U. S. Geol. Surve Bull. 1071-E, p. 121-155, 3 maps (2 in pocket, incl. col. geol. map, scale 1:62,500), 2 secs., diag. (in pocket), 1959, 19 refs.

The lower Marias River area includes about 800 sq. mi. in northern Chouteau, southwestern Hill, and southern Liberty counties. The mapped area consists of 4 15-min. quadrangles between 48°15'-48°3(N., 110°15'-111°15' W. Most of the area is a gent rolling terrain of low hills and shallow depressions. In the SW. corner of the mapped area the Marias River has entrenched itself about 200 ft. below the upland and has cut a broad valley.

Glacial deposits are widespread, and bedrock is exposed principally along the valley walls. The bed rock consists of sedimentary strata that range from the Colorado shale of Early and Late Cretaceous ag of which only rocks of Late Cretaceous age are exposed in this area, to the Judith River formation of Late Cretaceous age. These formations dip southeastward at about 35 ft. to the mile, although locally they have been folded into narrow southeastward-trending flexures. Of these, the most prominent ar 1) the Lothair nose, 2) an unnamed syncline, and 3) the Marias River dome.

In places, lenses of gravel tentatively correlated with the S. Saskatchewan gravels of Alberta crop ou between bedrock and till.

The glacial deposits are divided into 2 categories nonstratified drift (till) and stratified drift (glaciofluvial deposits). Two tills are recognized. An older till, the Lothair till, is light tan, tough, and indurated, and was deposited by an ice sheet (the Lothair ice) that overrode the entire area. Embedded in the Lothair till are lenses of sand and gravel and layers of yellow lacustrine silt. A younger till the Pondera till, is chocolate brown, semiplastic, and overlies the Lothair till in the southwestern par of the area. In many places the tills are separated by a layer of light-buff to yellow silt. Exact limits of the Pondera till are unknown, but most of it seem to be restricted chiefly to a broad divide in the sout western part of the area between the Marias River and Pondera Coulee.

The Pondera till was deposited by a wedge-shape narrow tongue of ice that advanced from the W. as far E. as the center of T. 29 N., R. 6 E., and that was marginal to a larger ice sheet to the W. Stratified drift that was deposited during the melt of each ice sheet is divided into 2 categories: outwash channel deposits formed away from the ice, and ice-contact deposits formed against the ice. The outwash-channel deposits consist of poorly to well stratified silt, sand, and gravel flooring shallow elongate valleys cut in till. Ice-contact deposits of the Lothair ice form kames, an esker, crevasse fillings, and other miscellaneous deposits for which no name is available. The ice-contact deposits of the Pondera ice form only kame terraces. Ice-contact

deposits of both ice sheets consist of poorly to well bedded silt, sand, and gravel enclosing till blocks.

The Early and Late Cretaceous history of the mapped area was one of alternating marine invasions and withdrawals. During the Tertiary the sedimentary strata were dissected by southeastward-flowing streams, among them the ancestral Marias River and its tributaries. The gorge of this former stream, now filled with till, can be traced eastward across the mapped area for about 50 mi. Other Tertiary drainage courses also were filled with till. When the Pondera ice withdrew, the Marias River entrenched itself and in so doing formed 4 terraces.

Economic deposits in the area consist principally of sand and gravel and minor amounts of poor quality riprap. Small coal seams and thin bentonite beds are exposed, but none are of commercial quality.

Strata that produce oil and gas elsewhere underlie the area, but a test well drilled in the Marias River dome was unsuccessful and it was abandoned as a dry hole after it penetrated the Madison limestone at a depth of 2,471 ft. The Eagle sandstone (Late Cretaceous) produces gas in adjacent areas.--Auth.

2-540. Bowles, Jack Paul Fletcher, Jr. SUBSURFACE GEOLOGY OF WOODS COUNTY, OKLAHOMA: Shale Shaker, v. 10, no. 4, p. 2-8, 10-20, 22-23, 9 maps, 3 secs., Dec. 1959, 32 refs.

Study of the subsurface geology of Woods County has revealed that, by evidence of converging strata northward from the southern trough area and the abundance of light-colored shallow-water limestones, this area is established as being on the platform of the Anadarko basin. Early Paleozic sediments as well as the Arbuckle [Cambro-Ordovician] and Simpson [Siluro-Devonian] converge N. and northwestward over the area and grade into dolomitic limestone, green shale, and thin well-cemented sandstones. Both the Viola and Sylvan formations [Ordovician] are truncated in the northern part of the county as the result of pre-Woodford uplift and erosion. The Hunton formations have been uplifted and eroded within the limits of the county, leaving subcrop bands that traverse irregularly from E. to W. Mississippian strata thin more rapidly as they approach the "Barber-Woods Swell." Movement during Early Pennsylvanian caused uplift and truncation of the Chester, Meramec, and Osage series. The Mississippi "Chat" was also formed at this time by ground-water solution and reworking of the Meramec and Osage rocks. Des Moinesian rocks are the earliest known Pennsylvanian deposits in the county. They transgressively overlap formations of Mississippian age. Rocks within the Missourian show a rapid change of facies from clastics to carbonates in the northern part of the county.

Minor unconformities are known to exist between the series of the Pennsylvanian, corresponding with rejuvenating uplifts in the Amarillo-Wichita, Arbuckle, Nemaha, and central Kansas tectonic regions. The unconformities are marked, however, as but minor fluctuations in sea level within this area.

The Wolfcampian series of early Permian is represented by a marine limestone sequence. Following this and extending throughout Leonardian, Guadalupian, and Ochoan deposition, the county lay within an isolated arm of the Permian sea. Its deposits include evaporites and red clastics.

There are but few subsurface structural features within the county, and they are represented by small folds and nosings. Stratigraphic traps, present in several units within the county, may be classified into 3 types: 1) angular unconformity, 2) change of facies, and 3) transgressive convergence.

Woods County offers a great variability in exploring for oil and gas, both in type of traps and reservoirs.--C. E. Branham.

2-541. Davis, Leon V. GEOLOGY AND GROUND-WATER RESOURCES OF SOUTHERN McCURTAIN COUNTY, OKLAHOMA: Oklahoma Geol. Survey, Bull. 86, 108 p., 15 maps (col. geol. map in pocket, scale approx. 1 in. to 2 mi.), 2 secs., diag., 2 graphs, 8 tables, 1960, 42 refs.

McCurtain County, in the southeastern corner of Oklahoma, is roughly rectangular, has an area of about 1,900 sq. mi., and had a population of about 31,388 (1950). The southern part of the county, considered in this report, is in the dissected Coastal Plain and is relatively flat, having a surface relief of about 200 ft. The county is drained by the Red and Little rivers.

Minerals resources consist of gravel, sand, clay, limestone, and oil and asphaltic sand. These mineral resources, other than sand and gravel for road ballast, are little used.

Sand, shale, and limestone, of Cretaceous age, underlie the surface of southern McCurtain County. The formations exposed, in ascending order, are the Holly Creek formation, De Queen limestone, Paluxy sand, Goodland limestone, Kiamichi formation, and lower part (Early Cretaceous) of the Washita group of the Comanche series, and the Woodbine formation, Tokio formation, and Brownstown and Ozan formations, undifferentiated, of the Gulf series (Late Cretaceous age). The regional dip is southward about 100 ft. per mi., locally interrupted by gentle folding. These formations are overlain along the large streams by alluvium and at other places by terrace deposits.

The Paluxy sand and the alluvium of the Red River are the most productive ground-water reservoirs in southern McCurtain County. The Paluxy is the source of public water supply for Valliant, Millerton, and Garvin. Municipal wells tapping water in this formation are generally less than 360 ft. deep, and their maximum yields are not more than 261 gallons per minute, which is considerably less than the Paluxy is capable of yielding to properly constructed wells that penetrate the entire water-bearing zone. The water is hard but has a relatively low mineral content.

A pumping test on the municipal water wells at Valliant was analyzed according to the Theis non-equilibrium formula and yielded about 14,000 g.p.d./ft. for the coefficient of transmissibility. From the same test a value of 4.2×10^{-5} was obtained for the coefficient of storage.

The sands of the Paluxy function are one large reservoir. Ground-water withdrawals from this reservoir have not appreciably affected the water levels except in the vicinity of Valliant, where a long-term drawdown has occurred since 1908.

The alluvium along the Red River has a maximum thickness of about 110 ft. The water contained in it is hard but suitable for most uses. However, it is reported to be saline in some places. The alluvium yields water from dug and driven wells for domestic and stock use. Yield of several hundred gallons per minute may be expected from properly constructed wells.--Auth.

2-542. Oakes, Malcolm C. GEOLOGY AND MINERAL RESOURCES OF CREEK COUNTY, OKLAHOMA.

With a section on Oil and Gas in Creek County, Oklahoma by Louise Jordan: Oklahoma Geol. Survey, Bull. 81, 134 p., 17 maps (2 under separate cover, scales 1 in to 1 mi., 1 in. to 2 mi.), 5 secs. (1 under separate cover), graph, 10 tables, 1959, 89 refs.

Creek County is an area of about 972 sq. mi. in the northeastern part of cental Oklahoma, the major part between Cimarron River and Deep Fork. Its NE. corner is barely 1 mi. S. of the limits of the city of Tulsa. Principal towns are Drumright, Bristow, and Sapulpa. Sapulpa is the county seat.

Creek County is situated on the N. flank of the western end of the Arkoma basin. The exposed consolidated rocks are transitional in character between the cyclic deposits of the shelf area of northeastern Oklahoma and Kansas, and the much thicker deposits of the basin. They are high in the Pennsylvanian section, above the productive coal beds. For the greater part, they are weakly resistant silty sandstones and sandy, silty shales. Sandstone accounts for about 1/3 of the thickness of the exposed rocks in the N. part of the county and about 1/2 in the S. part.

The shales that crop out in the E. part of the county, older than the Wann formation, are generally gray, and the associated sandstones weather brown or reddish brown. Shales that crop out in the rest of the county, of Wann age and younger, generally weather various shades of red, and the associated sandstones weather brownish red or red. Four thin sandy limestones are mapped in the W. part of the county and 2 in the E. part.

The nomenclature and classification of pre-Virgil rocks is the same as that used by the writer in his earlier work in Washington, Osage, and Tulsa counties, as reported in Oklahoma Geol. Survey, Bull. 62 and 69, 1940 and 1952. Several of the units continue into Kansas, and their Kansas names are used. The classification corresponds, in a general way, with that used in Kansas. There is, however, considerable gradual lateral change in the character of the rocks from northern Washington County to southern Creek County: for instance, the Dewey formation of Washington County consists of limestone and a minor amount of intercalated calcareous shale, but is generally more clastic southward, and in Creek County it consists of sandstone in the lower part and sandy shale in the upper part. It contains only thin lenses of small diameter of sandy limestone sparsely distributed in the shale.

Limits of the Virgil group in Oklahoma are comparable to its limits in Kansas. Names of Virgil units are derived from usage in northern Oklahoma and in Kansas, and, with modifications, from usage in the area between the North Canadian River and the N. flank of the Arbuckle Mountains.

Four unconformities are indicated in the Pennsylvanian rocks of Creek County: at the base of the Seminole formation, separating the Des Moines series from the Missouri series; at the base of the Chanute formation, separating the Skiatook group from the Ochelata group; at the base of the Barnsdall formation, within the Ochelata group; and at the base of the Vamoosa formation, separating the Missouri series from the Virgil series.

In general, the rocks that crop out in Creek County dip westward at low angles, 30 to 100 ft. per mi., most commonly about 60 ft. per mi. The low westward dip is modified in areas of local folds and faults, and in some localities the dip is eastward, for instance, on the E. flank of the Cushing anticline in northwestern Creek County, a few miles NE., E. and SE. of Drumright.

Economic resources of the exposed rocks are modest. They consist of impure limestones of sparse occurrence; chert gravel, in the S.-central part of the county; inferior sand; abundant shale suitable for brick, tile, and pottery; and considerable accumulations of ground water. In contrast, some of the subsurface rocks of Creek County are prolific sources of petroleum. Production of oil and gas is the principal occupation of the people, followed in order by farming and manufacturing.--Auth.

2-543. Russell, Dearl T. GEOLOGY OF NORTHERN LATIMER COUNTY, OKLAHOMA: Oklahoma Geol. Survey, Circ. 50, 56 p., 10 illus., 2 maps, (col. geol. map in pocket, scale 1 1/2 in. to 1 mi.), secs. (in pocket), diag., 1960, 47 refs.

Northern Latimer County is underlain by Pennsylvanian rocks of the Atoka, Hartshorne, McAlester, Savanna, and Boggy formations. Structural features are the Adamson anticline, Sansbois syncline, Burning Springs anticline, and Brazil anticline. Coal beds of commercial thickness are the Hartshorne coals and the McAlester coal.--Auth.

2-544. Johnson, Henry S., Jr. RECONNAISSANCE GEOLOGY AND PRELIMINARY APPRAISAL OF MINERAL RESOURCE POTENTIAL OF SUMTER COUNTY, S.C.: South Carolina, State Devel. Board, Div. Geology, Geol. Notes, v. 3, no. 5, p. 1-4, map, Sept.-Oct. 1959.

Sumter County is tentatively divided into 6 physiographic-geologic units as a basis for discussion of its mineral resource potential.

Unit I is thought to be underlain primarily by unconsolidated sands and clays of the Tuscaloosa formation of Upper Cretaceous age. Mineral resources are gravel, kaolin, and heavy minerals such as ilmenite, rutile, and zircon.

Unit II is underlain by sand, clay, buhrstone, and siliceous clay shale or "fullers earth" of Eocene and possibly Upper Cretaceous age. The principal mineral resources are "fullers earth" and sand-clay for highway construction.

Unit III is composed of sands and clays of probable Miocene age. Mineral resources are brick clay, silica sand, common borrow, and sand-clay mix.

Unit IV is composed predominantly of dune sands of probable Miocene or younger age. Mineral resources of this unit are essentially limited to silica sand.

Unit V consists of Pliocene or Pleistocene terrace deposits along the Wateree River. Mineral resources are sand, gravel, clay, and possible heavy minerals.

Unit VI is the floodplain of the Wateree and Santee rivers. Mineral resources are sand, clay, gravel, and possibly heavy minerals.

Oil and gas are not expected in commercial quantities, but ground water is available in abundance from wells yielding as much as 2,000 g.p.m.--Auth.

2-545. Foster, John M. GEOLOGY OF THE BISMARK PEAK AREA, NORTH TINTIC DISTRICT, UTAH COUNTY, UTAH: Brigham Young Univ., Dept. Geology, Brigham Young Univ. Research Studies, Geology Ser., v. 6, no. 4, 95 p., 3 illus., 3 maps (2 fold.), fold. diag., table, 1959, 86 refs.

The Bismark Peak area is part of the Boulter and E. Tintic mountains near Eureka, Utah. It comprises part of the N. Tintic mining district. The area has a strategic location because of its position

in respect to well-known mining areas such as Bingham, Mercur, and Ophir only a few miles to the N. and Park City, American Fork, Cottonwood Canyon, and Alta mining districts to the NE. The Tintic mining district which has produced approximately one-half billion dollars in metals adjoins the Bismark Peak area on the S.

Seventeen Paleozoic formations are present ranging in age from Lower Cambrian to Upper Mississippian. Over 11,000 ft. of stratigraphic section is exposed. Some volcanic rocks of very minor extent occur in the area.

The major structural feature is a N.-trending, N.-plunging anticline known as the N. Tintic anticline. It is overturned on the E. flank and has moderate to gentle dipping beds on the W. flank. This fold is approximately 6 mi. wide with a minimum known length of 15 mi. and an amplitude of 16,000 ft. Erosion has breached the anticline so that a valley is now present along the axis except in the area of this report.

An overthrust has occurred in the Boulter Peak area which has displaced the beds along the E. limb approximately 1 1/2 mi. eastward.

The writer mapped the geology of the area and in addition has produced a map showing areas where there has been alteration of the rocks by hydrothermal activity.

It is hoped that this report discussing the geology and showing areas of interest to prospectors and miners will serve to stimulate renewed interest in the Boulter Mountains and consequently help to add new metallic reserves to the state of Utah.--Auth.

2-546. Johnson, Kenneth D. STRUCTURE AND STRATIGRAPHY OF THE MOUNT NEBO-SALT CREEK AREA, SOUTHERN WASATCH MOUNTAINS, UTAH: Brigham Young Univ., Dept. Geology, Brigham Young Univ. Research Studies, Geology Ser., v. 6, no. 6, 49 p., 9 illus., 2 maps (1 fold. col.), 4 charts, 1959, 65 refs.

The area between Mount Nebo and Salt Creek lies at the junction of 3 physiographic and structural provinces, namely, the Great Basin, the middle Rocky Mountains, and the Colorado Plateau. The southern boundary of the mapped area separates 2 local provinces - those of the southern Wasatch Mountains and Gunnison Plateau.

The Mount Nebo - Salt Creek area embodies 2 sequences of rocks: 1) an older sequence of Paleozoic sediments comprising the upper plate of the Nebo overthrust, and 2) younger Mesozoic and Cenozoic sediments occupying the low foothills and valley areas, making up the sole of the thrust.

The area was subjected to compressive orogenic disturbances directed from the W. in middle and Upper Cretaceous times, resulting in the thrusting of Nebo and likely the Cedar Ridge thrust. Normal faulting of the Basin and Range disturbance in late Tertiary accounts for the Wasatch fault and most of the normal faults in the Salt Creek and Rees Flat area.

Water is the most important mineral resource at the present time. Several fans mantle the W. face of the mountain, the largest of which heads in Salt Creek Canyon. Wells recently drilled in Nephi produce an average of 5 to 6 sec.-ft. of water per well. Further production is anticipated.

Large quantities of rock gypsum were taken from Red Canyon and Salt Creek several years ago. Workable deposits still exist but the structural attitude of the gypsum has discouraged further development. --Auth.

2-547. Foster, Robert J. TERTIARY GEOLOGY OF A PORTION OF THE CENTRAL CASCADE MOUNTAINS, WASHINGTON: Geol. Soc. America, Bull., v. 71, no. 2, p. 99-125, 2 illus., 2 maps (1 fold.), table, Feb. 1960, 43 refs.

The central Cascade Mountains of Washington are composed largely of Tertiary continental and volcanic rocks. They lie between older metamorphic rocks to the N., Tertiary marine rocks to the W., and younger volcanic rocks to the S. and E. An eastward-dipping reverse fault through Lake Kachess separates 2 Tertiary basins of the same general age. This fault cuts Eocene rocks and is older than the Snoqualmie granodiorite.

E. of the fault the structures are open. The Swauk arkose unconformably covers pre-Tertiary peridotite and Easton schist. The Swauk is folded along NW. trends that become more E.-W. S. of Mount Stuart. This change in trend and the local origin of some of the Swauk suggest that the Mount Stuart block was high during early Tertiary time. Locally the Silver Pass volcanic rocks overlie the Swauk. The conformable sequence of Teanaway basalt-Roslyn arkose lies unconformably above the Swauk and is deformed into a broad basin. The nearly horizontal Yakima basalt unconformably overlies the older rocks.

W. of the Kachess fault, the structures are more complex. The oldest rocks are limy hornfels and marble of the Denny formation. They are overlain apparently unconformably by the sedimentary rocks of the Guye formation. Unconformably above the Guye is the extrusive Mount Catherine rhyolite; that is overlain by the tightly folded sedimentary rocks and basalt of the Naches formation. The mildly deformed Keechelus andesite overlies the Naches unconformably. The Snoqualmie granodiorite intrudes all the units in the western area.

Fossils are rare. A few vertebrate remains indicate that the Roslyn is probably middle or upper Eocene. Fossil leaves suggest that the Swauk and Guye formations are Paleocene or Eocene and the Naches is Eocene.--Auth.

2-548. Blyakhu, M., and R. Dimitrescu. BRIEF GEOLOGICAL DESCRIPTION OF THE ZAPADNYYE (WESTERN) MOUNTAINS. Translated by Research International: Internat. Geology, Rev., v. 1, no. 11, p. 58-72, 3 maps, 2 secs., Nov. 1959, 38 refs.

The crystalline basement is best exposed in the northern half of the Zapadnyye mountains. It consists of 2 large units, the Dzhileu and Aryesh suites, which differ in their lithology and development. These suites were metamorphosed in the Carboniferous, at which time the Peyushen formation was deposited. The Peyushen was metamorphosed during the Hercynian, simultaneously with formation of granite massifs. From the Hercynian to the end of the Cretaceous, 3 major areas of deposition were developed: 1) Bikhor, in which Triassic quartzites lie transgressively on the Dzhileu crystallines and Middle Triassic through Cenomanian limestones, dolomites, and flysch overlie the quartzite; 2) Kodru, characterized by a strong development of the Verrukano type underlain by Aryesh crystallines and overlain by the Bikhor-type Triassic sequence and Rhaetian clastics; 3) Meresh mountains, in which massive Malm limestones and Cretaceous through Cenomanian flysch overlie Paleozoic metamorphics. Magmatic activity occurred during the Permian, Triassic, Jurassic, and Cretaceous. The intrusions are primarily basic. In the Cretaceous, the Kodru

formations were thrust northward over the Bikhor area forming the basic structure of the mountain. It is proposed that a bilateral orogeny caused the thrust structures of the Zapadnyye mountains. One orogeny arose in the Zapadnyye, the other in the southern Carpathians. The thrust sheets are therefore reverse displacements resulting from a convergent movement of separate autochthonous blocks. --Auth.

2-549. Ravich, M.G., and F.G. Markov. PRINCIPAL GEOLOGIC AND METALLOGENIC FEATURES OF THE MOUNTAINOUS TAYMYR. Translated by Research International: Internat. Geology Rev., v. 1, no. 11, p. 28-36, Nov. 1959, 12 refs.

Within the mountainous Taymyr the oldest formations are highly metamorphosed sedimentary and extrusive rocks of Proterozoic age, overlain by less altered rocks of the Sinian complex. These in turn are overlain with angular unconformity by Lower Cambrian deposits, whose age has been determined on the basis of fossils. Paleozoic rocks are widespread, and all systems of the era are represented. Proterozoic rocks occur on the northern coast of the peninsula. The younger Sinian and Paleozoic formations are S. and SE. of these. Mesozoic rocks constitute small areas in depressions. Quaternary sediments, consolidated by permafrost, are widely distributed throughout the area. Magmatic activity is well developed. The lower Proterozoic magmatic cycles began with intrusion and extrusion of basic rocks, and ended with granitoid injections accompanied by formation of pegmatitic zones. In the upper Proterozoic, magmatic activity is again characterized in early stages by extrusion and intrusion of basic rocks, and later by the formation of granitic intrusions and their facies, as well as by extrusion of felsite porphyry towards the end of the era. Intrusions of granitoids appeared in the middle Paleozoic. The upper Paleozoic was marked by the formation of trap rock and sulfide mineralization. In the early Mesozoic, the occurrence of small subalkaline intrusions resulted in the formation of ores of various types. --Auth.

2. GEOMORPHOLOGY

See also: Areal and Regional Geology 2-539; Sedimentary Petrology 2-711; Engineering Geology 2-766, 2-772.

2-550. Wolman, M. Gordon, and John P. Miller. MAGNITUDE AND FREQUENCY OF FORCES IN GEOMORPHIC PROCESSES: Jour. Geology, v. 68, no. 1, p. 54-74, 5 diags., 10 tables, Jan. 1960, 41 refs.

The relative importance in geomorphic processes of extreme or catastrophic events and more frequent events of smaller magnitude can be measured in terms of 1) the relative amounts of "work" done on the landscape and 2) in terms of the formation of specific features of the landscape.

For many processes, above the level of competence, the rate of movement of material can be expressed as a power function of some stress, as for example, shear stress. Because the frequency distributions of the magnitudes of many natural events, such as floods, rainfall, and wind speeds, approximate log-normal distributions, the product of frequency and rate, a measure of the work performed by events having different frequencies and magnitudes will attain a maximum. The frequency at which this maximum occurs provides a measure of the level at which the largest portion of the total work is accomplished. Analysis of records of sediment transported by rivers indicates that the largest portion of the total load is carried by flows which occur on the average once or twice each year. As the variability of the flow increases and hence as the size of the drainage basin decreases, a larger percentage of the total load is carried by less frequent flows. In many basins 90% of the sediment is removed by storm discharges which recur at least once every 5 years.

Transport of sand and dust by wind in general follows the same laws. The extreme velocities associated with infrequent events are compensated for by their rarity, and it is found that the greatest bulk of sediment is transported by more moderate events.

Many rivers are competent to erode both bed and banks during moderate flows. Observations of natural channels suggest that the channel shape as well as the dimensions of meandering rivers appear to be associated with flows at or near the bankfull stage. The fact that the bankfull stage recurs on the average once every year or 2 years indicates that these features of many alluvial rivers are controlled by these more frequent flows rather than by the rarer events of catastrophic magnitude. Because the equilibrium form of wind-blown dunes and of wave-formed beaches is quite unstable, the frequency of the events responsible for their form is less clearly definable. However, dune form and orientation are determined by both wind velocity and frequency. Similarly, a hypothetical example suggests that beach slope oscillates about a mean value related in part to wave characteristics generated by winds of moderate speed.

Where stresses generated by frequent events are incompetent to transport available materials, less frequent ones of greater magnitude are obviously required. Closer observation of many geomorphic processes is required before the relative importance of different processes and of events of differing magnitude and frequency in the formation of given features of the landscape can be adequately evaluated. --Auth.

2-551. Schwarzacher, W. PACK-ICE STUDIES IN THE ARCTIC OCEAN: Jour. Geophys. Research, v. 64, no. 12, p. 2357-2367, 2 illus., profile, 4 diags., 2 graphs, 2 tables, Dec. 1959, 11 refs.

The annual stratification of pack ice has been examined. Summer layers are formed either by arrested growth or by thin layers of fresh-water ice. The crystal structure and the salt content of the ice reflect that seasonal cycle. During the growth of ice a pronounced orientation of crystalline structure develops; it is determined by vertical as well as by horizontal temperature gradients.

There is a marked and systematic increase of salinity with depth, ranging from about 0.1 per mil at the surface at 4.0 per mil at a depth of 300 cm. This salinity distribution remains unaltered during the summer melt season.

A tentative attempt has been made to reconstruct

the growth history of the ice at Drifting Ice Station A. This shows that the winter growth is strongly related to the thickness of the ice, that the floe on which the station was located was probably 8 years old, and that during each of the winters of 1955-1956, 1956-1957, and 1957-1958 the thickness of the ice increased nearly 60 cm.--Auth

2-552. Jenness, Stuart E. LATE PLEISTOCENE GLACIATION OF EASTERN NEWFOUNDLAND: Geol. Soc. America, Bull., v. 71, no. 2, p. 161-179, 7 maps, sec., table, Feb. 1960, 54 refs.

Melting of the late Pleistocene ice sheet has left a semicircle of glacial deposits around the coast of eastern Newfoundland W. of the Avalon Peninsula. A discontinuous end moraine accentuates the curvature and separates ground moraine on the coastal side (outer drift zone) from slightly younger eskers, kames, and ground moraine on the inner side (inner drift zone). The distribution of ground moraine, glacial striations, indicator boulders, and glaciated bedrock ridges in the 2 drift zones indicates that an ice sheet once covered all eastern Newfoundland W. of the Avalon Peninsula. The ice center was somewhere in western Newfoundland. At about the same time local ice caps existed on the Avalon Peninsula. Small valley glaciers persisted in a few elevated regions of the N. and S. coasts W. of longitude 55° after the retreat of the main ice sheet.

Eastern Newfoundland appears to be tilting upward toward the NW., with a zero isobase passing through Trinity and Placentia bays. NW. of this axis the coast is emerging; SE. of it (on the Avalon Peninsula) the coast is submerging. The zero isobase veers W. along the S. shore of Newfoundland, parts of which are submerging, parts emerging.--Auth.

2-553. Brush, Lucien M., Jr., and M. Gordon Wolman. KNICKPOINT BEHAVIOR IN NONCOHESIVE MATERIAL: A LABORATORY STUDY: Geol. Soc. America, Bull., v. 71, no. 1, p. 59-73, map, 3 diags., 9 graphs, 4 tables, Jan. 1960, 11 refs.

Short oversteepened reaches were molded in the beds of model channels formed in well-sorted, noncohesive sands 0.67 mm. and 2 mm. in diameter. In each run of the experiment a fall of 0.1 ft. in a length of 1.0 ft. was provided. The over-all slopes of the channels upstream and downstream from the oversteepened reach were made equivalent and ranged from 0.0012 to 0.0088. The abrupt break in the profile at the head of the oversteepened segment constituted a knickpoint. Progressive changes in the position of the knickpoint and in the slope of the oversteepened reach were measured during runs in which discharge, over-all slope, and particle size were varied independently.

In every run, the slope of the water surface and the slope of the bed below the knickpoint decreased with time. As the knickpoint moved upstream, the channel directly above the knickpoint first steepened and narrowed. Following the initial steepening, the slope became progressively less. At the lower end of the oversteepened reach, sediment eroded from above was deposited as a dune, which advanced downstream and caused the channel to widen and locally to steepen. Following the passage of the dune, the slope again flattened.

For runs with identical initial (over-all) slopes, discharge, and widths, the slope below the knickpoint decreased faster in the channel of finer sand.

The rate of change of slope in the oversteepened reach below the knickpoint depends upon the magnitude and the rate of change of erosion along this reach which, in turn, depends upon the magnitude and the rate of change of the sediment transport along the reach. If the rate of transport is great, the oversteepened slope below the knickpoint is reduced rapidly. Analysis of the data indicates that the higher the ratio of the oversteepened slope to the average slope the more rapid the rate of decrease of the oversteepened slope. These results are comparable to changes observed in natural stream channels following meander cutoffs.

The laboratory experiment confirms the observation that upstream migration of knickpoints accompanied by undiminished slopes does not occur in noncohesive, homogeneous bed material. Several hypothetical cases are discussed in which it is assumed that resistant material is present in the channel profile.--Auth.

2-554. Melton, Mark A. INTRAVALLEY VARIATION IN SLOPE ANGLES RELATED TO MICROCLIMATE AND EROSIONAL ENVIRONMENT: Geol. Soc. America, Bull., v. 71, no. 2, p. 133-144, diag., graph, 5 tables, Feb. 1960, 11 refs.

E.- or W.-trending stream valleys that have erosional slopes have been reported to be 1) asymmetrical with the N.-facing slopes steeper, 2) asymmetrical with the S.-facing slopes steeper, and 3) symmetrical, with both sides of equal mean slope angle. A series of measurements of angles of erosional slopes, taken in 3 E.-trending, low-gradient valleys in the Laramie Range, Wyoming, shows that N.-facing slopes there tend to be 4.42° steeper than opposed S.-facing slopes; slope angle is further affected by nearness to the channel. In valleys that have channel gradients greater than 6° and greatly differing vegetation density across the valley, measurements of slope angles definitely show valley symmetry. The interpretation given is that unless the channel has been maintained against the base of the N.-facing slope by greater slope wash from the S.-facing slope, vegetation differences and resulting rates of slope erosion alone do not produce asymmetric valleys. Valley asymmetry that results from a variety of basic causes can be attributed to a single mechanism, asymmetric lateral corrosion by the stream.

Difference in frost action on N.-and S.-facing valley sides is rejected as a cause of valley asymmetry in the areas studied because 1) the asymmetry is opposite that reported in tundra regions elsewhere, and 2) the degree of asymmetry in 2 widely separated areas does not reflect differences in the degree of frost activity in the 2 areas.--Auth.

2-555. U.S. Waterways Experiment Station. HANDBOOK. A TECHNIQUE FOR PREPARING DESERT TERRAIN ANALOGS: Its: Tech. Rept. no. 3-506, 70 p., 19 col. maps, approx. 15 figs. incl. illus., maps, diags., graphs, tables, May 1959, 30 refs.

A technique is described whereby desert areas selected for terrain comparison are mapped in terms of general terrain factors, geometry factors, ground factors, and vegetation. General terrain factors include physiography, hypsometry, and landforms. Geometry and ground factors considered are characteristic slope, characteristic relief, occurrence of slopes greater than 50%, characteristic plan-profile, soil type, soil consistency, and surface rock. Terrain-factor data

are synthesized to establish varying degrees of analogy of particular desert areas with portions of a selected base area. (The Yuma Test Station served as the base area for the present study.) This synthesis includes compilation of geometry, ground, and vegetation analog maps - through combination of their component terrain-factor maps. If a geometry type (identified by 4 numbers - each representing a particular range of values of the geometry terrain factors) found within the base area also occurs in another desert area, the tracts are considered highly analogous. A tract exhibiting 3 numbers out of 4 that occur in combination within the base area is considered to be moderately analogous, and so on. Ground and vegetation analog maps are prepared in a similar fashion through utilization of their respective terrain-factor maps.

A composite analog map is prepared by superimposing geometry, ground, and vegetation analog maps and stratifying the resulting combinations. Highly analogous desert tracts exhibit, or closely approximate, combinations of terrain-factor mapping units found in the base area, and the degree of analogy decreases directly as the similarity to such combinations decreases.

Small areas mapped at large scales can be compared with areally similar tracts or with large regions mapped at smaller scales.--Auth. summ.

2-556. Laktionov, A. F. BOTTOM TOPOGRAPHY OF THE GREENLAND SEA IN THE REGION OF NANSEN'S SILL. Translated from Priroda, 1959, 10, 95-97, by E. R. Hope: Canada, Directorate Sci. Inf. Service, Defence Research Board, [Translations] T 333 R, 3 p., 3 maps, profile, Nov. 1959, 8 refs.

In 1912 F. Nansen concluded that the central Arctic and the northern part of the Greenland Sea were separated by a submarine ridge which, to a certain extent, prevented the invasion of the higher latitudes of the Arctic by cold, deep waters of the Greenland Sea. A German expedition in 1938 concluded that the sill did not exist. Soviet oceanographic research in 1955-1956 established that a continuous Nansen's sill as has been hitherto charted does not exist. The sill is cut through by a deep-water trough, the axis of which extends N.-S. along meridian 1°W. Depths in the center of the trough range from 3,100 m. to 3,900 m.--M. Russell.

2-557. Bailey, Paul. PHYSICAL LONG ISLAND; ITS GLACIAL ORIGIN, HISTORIC STORMS, BEACHES, PRAIRIES AND ARCHAEOLOGY: 130 p., 111 illus., map, sec., Amityville, New York, Long Island Forum, 1959.

During the past few decades Long Island, New York, has undergone drastic changes. Within living memory vast sections of its plains and outer beaches have passed from a more or less primeval state into the pattern of modern development. The island's physical changes have seldom been touched upon for the layman except as an essential part of the human story. Though most of these changes have been going on constantly during the more than 3 centuries of white inhabitance, they have not been correlated with any degree of continuity. Although geologists, topographers, and archeologists have covered their chosen fields much more fully, this book attempts to describe from a layman's viewpoint the island's physical changes and the causes thereof.--From auth. pref.

Contents:

1. The Island's Geological Background
   The Glacial Period - Boulders, Kettle Holes and Topographical Features.
   The Barrier Beaches - Dunes and Inlets. Their Origin and Corrosion.
2. Mid-Island Plains and Prairies
   Their Glacial Origin.
   Belated Development.
3. Historic Storms
   Disastrous Hurricanes and Blizzards.
   Waterspouts Ashore
   Year Without a Summer.
4. Archaeological Discoveries
   Aboriginal Village Sites
   Fire-Pits and Pottery.
   Numerous Artifacts Found.

3. STRUCTURAL GEOLOGY

See also: Geologic Maps 2-529; Areal and Regional Geology 2-547; Stratigraphy 2-583, 2-590; Engineering Geology 2-762.

2-558. Cleary, James M. HYDRAULIC FRACTURE THEORY. PART III. - ELASTIC PROPERTIES OF SANDSTONE: Illinois State Geol. Survey, Circ. 281, 44 p., 3 illus., 13 diags., 10 tables, 1959, 23 refs.

This study, the last of a 3-part series [Pts. 1 and 2, see Geological Abstracts, v. 6, no. 2, p. 157, June 1958], was undertaken primarily to evaluate certain elastic properties of the porous sandstones. Such properties may be used in calculating the changes in underground stresses that take place as pore pressure changes. As the underground stresses control hydraulic fracture propagation, knowledge of these stresses is important in recovery of oil.

Samples of sandstone were subjected to changes in pore pressure and external stresses. The resulting strains were measured by resistance wire gages and the elastic properties computed.

In Pts. 1 and 2 of the project, the hydraulic fracturing process was examined as a problem in applied mechanics, with particular emphasis on elasticity. It was concluded that hydraulic fracture propagation was controlled mainly by the horizontal stress in the rock and that this stress would change with the pore pressure.

The laboratory data of Pt. 3 confirm experimentally the predicted horizontal stress changes. Elastic properties of the sandstone were found to vary with mean effective stress. The regular variation of elastic properties with porosity should allow rough prediction of elastic behavior of a given type of rock on the basis of porosity.--Auth.

2-559. Ramberg, Hans. RELATIONSHIPS BETWEEN LENGTH OF ARC AND THICKNESS OF PTYGMATICALLY FOLDED VEINS: Am. Jour. Sci., v. 258, no. 1, p. 36-46, 2 illus., 2 diags., Jan. 1960, 11 refs.

Certain aspects of folding of a competent rock layer (ptygmatic vein) embedded in incompetent rocks is treated theoretically. If both rocks are considered as Newtonian substances with high viscosity coefficients, one finds the following relationship between initial wavelength, λ_i, (= length of arc of a wave),

thickness of competent layer, $2h$, and viscosity coefficient of competent and incompetent rocks, μ_1 and μ_2, respectively:

$$\lambda_1 = 2\pi h \sqrt[3]{\frac{2}{3}\mu_1/\mu_2}$$

The buckling layer gives rise to a sinusoidal contact strain in the host. The depth of penetration of the contact strain into the host is calculated to be $Z_C = \frac{2}{\pi}\lambda_1$. This agrees well with experiments.--Auth.

2-560. Pakiser, Louis C. TRANSCURRENT FAULTING AND VOLCANISM IN OWENS VALLEY, CALIFORNIA: Geol. Soc. America, Bull., v. 71, no. 2, p. 153-159, map, diag., Feb. 1960, 24 refs.

In the Owens Valley region of California, volcanic activity of Cenozoic age was confined mainly to 3 areas near the ends of important faults. The volcanic eruptions seemingly took place in regions of relative tension, if the horizontal movement along these faults was left lateral. The deep depression of Owens Valley may have resulted from compression associated with left-lateral horizontal fault movement. The transfer of molten rock from beneath this deep depression laterally into the regions of tension and thence to the surface seems to account for the relief of abnormal stresses and the volume of the volcanic rocks.--Auth.

2-561. Kupfer, Donald H. THRUST FAULTING AND CHAOS STRUCTURE, SILURIAN HILLS, SAN BERNARDINO COUNTY, CALIFORNIA: Geol. Soc. America, Bull., v. 71, no. 2, p. 181-214, 8 maps (3 fold.), secs., 4 diags., Feb. 1960, 37 refs.

In the Silurian Hills, 15 mi. SE. of Death Valley, California, the dominant structure is the Riggs thrust. Beneath the thrust older Precambrian metamorphic rocks are overlain by the later Precambrian Pahrump group. Above the thrust are Paleozoic(?) carbonate rocks (Riggs formation, provisional name) and Tertiary(?) rocks, in part sedimentary and in part volcanic. Unconformably on all these bedrock units are a monolithologic carbonate megabreccia, fan gravels of 2 ages, and several terrace gravels. The topography is controlled by lithology and structure, drainage is subsequent, and scarps are either erosional or fault line.

The Pahrump group in the Silurian Hills is 11,000 ft. thick and is subdivided into 35 mappable members, chiefly coarse clastic rocks derived from the S. Correlation with the 3 formations of the type Pahrump in the Kingston Range, 15 mi. N., is uncertain.

Granitic rocks of 2 or more ages intrude the Riggs and Pahrump rocks. Distinctive members of the Pahrump group can be traced from unmetamorphosed sedimentary rocks in the W. to intensely feldspathized and metamorphosed rocks in the E. The older grantitic rock is displaced by the Riggs thrust fault; the younger granitic rock is both localized by the fault and displaced by it. Most of the movement on the N.-trending, high-angle faults is prethrust, but contemporaneous and postthrust movement occurred.

The Riggs thrust was apparently localized along the angular unconformity between the Riggs and Pahrump rocks. The thrust surface is anticlinal or dome-shaped, probably because of postthrust warping. The thrust zone is a "chaos" similar to the type chaos, the Amargosa chaos described by Noble (particularly the Virgin Spring phase), except that it is composed chiefly of rocks from the footwall of the thrust instead of the plate. Detailed mapping of the chaos, possible because many of the members or beds in the Pahrump group are distinctive, shows that component fragments were carried southwestward as much as 2 mi. from their original position in the autochthon and were piled up in an imbricate structure in which normal stratigraphic order is approximately maintained. The amount of movement was not determined, but the distribution of granitic rock in and under the plate suggest a mimimum movement of 8 mi. A debris-flow megabreccia covers the eroded trace of the Riggs thrust fault. The Tertiary(?) volcanic rocks are folded and confined to the thrust plate, which suggests that the less intensely folded Riggs thrust is younger.

Chaos structures may have formed by the imbrication and piling up of a whole series of very small thrust plates above an underlying block, which was being shortened under compression. A few strong, competent plates moved out several miles without being broken up appreciably, but most plates broke up into giant lenses and blocks that moved much shorter distances. The incompetent material was ground up and acted as a lubricant. The stratigraphic section, thus "skeletonized" and abbreviated into "chaos," retained a crude stratigraphic order.--Auth.

2-562. Mackin, J. Hoover. STRUCTURAL SIGNIFICANCE OF TERTIARY VOLCANIC ROCKS IN SOUTHWESTERN UTAH: Am. Jour. Sci., v. 258, no. 2, p. 81-131, 10 figs. incl. map, secs., tables, Feb. 1960, 105 refs.

Most of the silicic volcanic rocks of the Great Basin are ignimbrites rather than lava flows. The more common types were probably formed by nuées ardentes which spread laterally as density currents of very high fluidity, but there are aberrant types that may be in some manner transitional between ignimbrites and lava flows, and the whole problem of mechanism of origin is as yet little understood. Uncertainty on this score is of no concern here; mapping of many of the units indicates that, whatever their origin, they assumed a distribution approaching that of an equal volume of water, filling valleys to a common level and forming sheets of substantially uniform thickness where the relief of the pre-existing surface was low. Some of the individual ignimbrites are many hundreds of feet thick and have an areal extent of as much as 10,000 sq. mi. Because each of these extensive and initially flat sheets was formed everywhere at the same instant of time, they are very nearly ideal stratigraphic units. They occur in most parts of the Great Basin and range in age through most of the Tertiary.

Eleven ignimbrites which are widespread in southeastern Utah are described and given formal stratigraphic names. The fact that the oldest of them lies unconformably across the beveled edges of thrusts and folds involving late Cretaceous strata indicates that the beginning of volcanic activity postdates the Laramide orogeny. As planar units which provide a record of Tertiary crustal movements, the ignimbrites confirm the Gilbert theory, based originally on physiographic evidence, that block faulting has been the characteristic type of post-Laramide deformation in the Great Basin. The stratigraphic-structural approach makes it possible 1) to work out the geometry of the block faulting with a precision not obtainable by use of displaced erosion surfaces; 2) to deal with episodes of block faulting that occurred during the early Tertiary and are not expressed by the present topography; and 3) to crossdate these and other geologic events on a regional scale.

On the basis of detailed work in southwestern Utah, and reconnaissance elsewhere, it is stated as a deliberately provocative working hypothesis that block faulting has been the only type of regional tectonism in the Great Basin in postorogenic time. The first requirement in testing this hypothesis is the recognition, as such, of flexures and thrust faults developed 1) by emplacement of hypabyssal intrusions, and 2) by gravity sliding from primary relief features raised by intrusion and block faulting. These 2 classes of structures are of much interest in their own right; their significance for present purposes is merely that they may be readily mistaken as evidences of regional tectonism. Equally critical is the need for distinguishing postorogenic deformational effects from those produced during the orogeny. Examples are given of use of the ignimbrites in making these distinctions.--Auth.

2-563. Ez, V.V. SOME PROBLEMS ON THE ORIGIN OF FOLDING. Translated by Royer and Roger, Inc.: Internat. Geology Rev., v. 1, no. 11, p. 48-57, illus., 4 secs., 5 diags., Nov. 1959, 25 refs.

The mechanism of geosynclinal folding has been explained variously by vertical compression, wave motion, shearing action, competent folding, and laminar redistribution of material within beds. Theoretical objections to various aspects of the major hypotheses are reviewed. The 2 principal classes of folds, concentric and similar, grade from one to the other. Horizontal compression, applied not only to the edge of a belt of folding, but uniformly throughout the area of folding is a significant mechanism. No new hypothesis is proposed but rather the relationship of seemingly different phenomena of folding is emphasized.--M. Russell.

2-564. Ramsay, John G. THE DEFORMATION OF EARLY LINEAR STRUCTURES IN AREAS OF REPEATED FOLDING: Jour. Geology, v. 68, no. 1, p. 75-93, 3 maps (1 fold.), 2 secs., 24 diags. (3 fold.), 5 tables, Jan. 1960, 18 refs.

The geometry of originally rectilinear structures deformed during a later phase of fold movement is described. Lineations lying on a surface which is deformed by concentric folding have their locus on a partial cone (stereogram plots show a partial small circle pattern), whereas those lying on a surface folded in a similar manner have their locus on a plane (stereogram plots show a great circle pattern). A method of determining the actual movement or a-direction of particles during similar folding is described. The fold axis is not necessarily at right angles to this a-direction.--Auth.

2-565. Heron, S. Duncan, Jr. A SMALL BASEMENT CORED ANTICLINAL WARP IN THE BASAL CRETACEOUS SEDIMENTS NEAR CHERAW, SOUTH CAROLINA: South Carolina, State Devel. Board, Div. Geology, Geol. Notes, v. 3, no. 4, p. 1-4, sec., July-Aug. 1959, ref.

An outcrop near Cheraw, South Carolina, shows the contact between crystalline basement rocks of Paleozoic(?) age and the overlying Middendorf formation of Cretaceous age. The Middendorf sediments are draped over a hill-like mass of basement rock so as to form a basin or synclinal warp adjacent to an anticlinal warp. The origin of the warping is not clear but it is not due to sedimentary processes because the high clay sediments maintain an even thickness over the top of the basement "hill"; differential compaction is ruled out for the same reason. A tectonic origin is unlikely because of no other evidence of tectonic activity in the area and because of the general appearance of the structure. The most logical hypothesis for the origin of the structure is varying susceptibility of the basement argillite to weathering and solution which brought about differential compaction of the basement rocks with the resulting letdown of the overlying Cretaceous sediments.--Auth.

2-566. Licht, A.L. CONVECTION CURRENTS IN THE EARTH'S MANTLE: Jour. Geophys. Research, v. 65, no. 1, p. 349-353, 4 diags., Jan. 1960, 8 refs.

Recent measurements by J. A. O'Keefe, A. Eckels, and R. K. Squires of the third zonal harmonic component of the earth's gravitational potential are used to determine the characteristics of a hypothetical convection current in the earth's mantle. The calculations are based on a convection theory developed by F. A. Vening Meinesz. The current's velocity is found to be 3.6 cm./year, corresponding to an overturn time of 1.75×10^8 year. The temperature perturbation is found to be $9.7^{\circ}C$. The flow is found to impose a distortion of 159 m. on the earth's crust and a distortion of 237 m. on the surface of the core. The mass loadings associated with these distortions were calculated as 5.3×10^7 dyne/cm.^{2} at the top, and 8.9×10^7 dyne/cm.^{2} at the bottom of the mantle. It is believed that the Vening Meinesz theory is capable of qualitatively explaining the results of O'Keefe and his co-workers. However, the required thermal efficiency is about 70%, as compared with an estimated maximum of 4%. It is considered improbable that convective efficiencies could be so large.--Auth.

2-567. Huang, T.K. NEW STUDIES ON THE GEOTECTONIC SUBDIVISIONS OF EASTERN CHINA AND THEIR CHARACTERISTICS. Translated by Royer and Roger, Inc.: Internat. Geology Rev., v. 1, no. 11, p. 73-88, map, Nov. 1959, 24 refs.

The major characteristics and subdivisions of the Chinese platform are described and compared with standard Russian platforms. Because a typical Chinese platform subdivision is clearly different it is proposed to designate such a subdivision a paraplatform. Two paraplatforms and a massif comprise the Chinese platform. The S. Chinese paraplatform is the most mobile, having undergone multiple folding and faulting with magmatic activity. By comparison, the Sino-Korean massif is less mobile and underwent only 1 cycle of deformation. The NE. paraplatform is similar to the S. Chinese paraplatform in structural elements and history. Deep rupture zones are significant elements of the structure of the Chinese platform.--M. Russell.

See also: Geologic Maps 2-530; Areal and Regional Geology 2-540; Structural Geology 2-565; Paleontology 2-596, 2-603, 2-619, 2-623; Sedimentary Petrology 2-709; Mineral Deposits 2-733, 2-735; Fuels 2-757.

2-568. Wilson, John Andrew. TRANSFER, A SYNTHESIS OF STRATIGRAPHIC PROCESSES: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 12, p. 2861-2862, Dec. 1959.

The 3 stratigraphic processes - erosion, nondeposition, and deposition - should be treated as a single process called transfer.--I. M. Johnson.

2-569. Bell, W. Charles. UNIFORMITARIANISM - OR UNIFORMITY: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 12, p. 2862-2865, Dec. 1959.

Although radiometric dating may at some time in the future provide data from which to construct a calendar of geologic time, the chronologic foundation of the present geologic time scale has been, and is, fossils.

In reality the unit of stratigraphic classification is the "time unit" (series and stage) and not the "time-stratigraphic unit." From the "time-stratigraphic unit" we have derived the concept of the "time unit."

The idea of the type section has been strongly emphasized in the United States from an early date. The type section for a rock-stratigraphic unit is at best only "typical" of what the original describer saw and should not be used to freeze the concept intended.

Paradoxically, although we give lip-service to an awareness of isochronous but different facies when we write, in practice we say that similarity implies isochroneity - in other words, the doctrine of uniformitarianism becomes the doctrine of uniformity. A long distance today between homotaxial sequences can support the hypothesis of isochroneity or the hypothesis of continental drift without proving either one.--I. M. Johnston.

2-570. McDaniel, Gary A. ISOPACHOUS AND PALEOGEOLOGIC STUDIES OF SOUTHWEST OKLAHOMA: Shale Shaker, v. 10, no. 3, p. 4-8, 10-24, 26-27, 16 maps, chart, diag., Nov. 1959, 26 refs.

SW. Oklahoma can be subdivided into 3 main tectonic features: the Amarillo-Wichita-Criner Hills uplift, the Anadarko basin and the Hollis basin.

Isopachous maps of the different formations indicate the following conclusions. The Arbuckle Timbered Hills group [Cambrian] has a maximum thickness of 6,275 ft. but has only an average thickness of 1,500 ft. in the area. The Simpson [Ordovician] section varies from zero on the uplift to 2,377 ft. in the Anadarko basin. The maximum thickness of the Simpson in the Hollis basin is 636 ft. The Viola Fernvale [Ordovician] section varies from zero to 695 ft. into the Anadarko basin and as was the case with the older formations, the trend of the basin is delineated by the NE.-SW. thickening and thinning. The thickest Viola preserved in the Hollis basin is 327 ft.

The axis of maximum thickness of the Hunton formation [Siluro-Devonian] in the Anadarko basin lies along an arcuate line drawn from T. 12 N. R. 25 W. to T. 3 S. R. 4 W. The thickest section drilled was 2,420 ft. The Woodford shale [Devonian-Mississippian] although affected by the Oklahoma City uplift to the NE. where it has thinned to 50 ft. still has a maximum thickness of 773 ft. in the Anadarko basin. The Woodford shale is absent S. of the uplift. The Mississippian formation shows a rapid thickening into the Anadarko basin, from zero in the Mountain area to 4,567 ft. in the Anadarko basin. The Mississippian has a maximum thickness of 1,758 ft. in the Hollis basin.

The Springer series [Pennsylvanian] has a maximum thickness of 6,000 ft. in Caddo County and thins to zero SW. of a line from T. 10 N. R. 26 W. to T. 4 S. R. 4 W. The Morrowan [Pennsylvanian] isopach shows westward shifting of the axis of maximum deposition compared to the Springeran deposition. Maximum thickness encountered was 4,333 ft. The Atokan [Pennsylvanian] reaches a maximum thickness of 5,000 ft. in the Anadarko basin and 1,508 ft. in the Hollis basin.

Paleogeologic maps indicate the Amarillo-Wichita-Criner axis remained positive during Woodford time but had its culmination during Pennsylvanian time. Structure contour maps show the configuration of the Anadarko and Hollis basin and the related uplift between.--C. E. Branham.

2-571. Amsden, Thomas W. STRATIGRAPHY AND PALEONTOLOGY OF THE HUNTON GROUP IN THE ARBUCKLE MOUNTAIN REGION. PART VI. HUNTON STRATIGRAPHY: Oklahoma Geol. Survey, Bull. 84, 311 p., 67 illus. (66 on 17 pls.), 31 maps (5 in pocket), chart, 11 secs. (4 in pocket), 25 diags., 1959, 60 refs.

The Hunton group comprises a sequence of carbonate strata which crop out in the Arbuckle Mountain region and Criner Hills of S.-central Oklahoma. It is a thin group of strata and within the outcrop area only locally attains a thickness of slightly more than 400 ft. The Hunton group is divided into the following formations and members:

Devonian	Frisco formation unconformity Bois d'Arc formation Fittstown member Cravatt member Haragan formation unconformity
Silurian	Henryhouse formation unconformity Chimneyhill formation Clarita member unconformity Cochrane member unconformity Keel member Ideal Quarry member

These strata range in age from Early Silurian to Early Devonian, but the record is quite incomplete, and there are several time breaks marked by unconformities.

The present report presents the results of a study based on a field investigation covering all of the major Hunton outcrop belts; a number of stratigraphic sections were measured and collected, and certain local areas were mapped in detail. This field work was supplemented by a laboratory study of the lithology by means of paralodion peels, thin sections, insoluble residues, and chemical analyses. Numerous fossil collections were made, but this report does not include descriptive paleontology and gives only summary data on the fossils and their age. The information which appears to have a bearing on environment of deposition is discussed, and it is concluded that except for the Keel-Ideal

Quarry beds, which appear to have formed in shallow water, the Hunton rocks are mostly the product of offshore deposition, mainly out of the zone of effective wave action; the text concludes with a short chapter on the depositional and erosional history of the group. The Appendix records all of the described stratigraphic sections and tabulates the chemical analyses.

The cherty carbonates and siltstone which crop out near Oil Creek and in the Turkey Creek inlier are discussed in some detail. These strata have commonly been assigned to the Hunton, but evidence is presented pointing to a post-Hunton age.--Auth.

2-572. Cumming, L. M. SILURIAN AND LOWER DEVONIAN FORMATIONS IN THE EASTERN PART OF GASPÉ PENINSULA, QUEBEC: Canada, Geol. Survey, Mem. 304, 45 p., 7 illus., 9 figs, incl. maps, secs., 1959, 78 refs.

A belt of Cambro-Ordovician shales and limestones up to 20 mi. wide runs roughly parallel with the N. shore of Gaspé peninsula. S. of this belt lies the central Gaspé basin containing Silurian and Devonian sedimentary rocks, with some granite intrusions and volcanic rocks in the N.-central part. The Gaspé limestone of Logan outcrops along the N. side of the basin and is treated as a group, comprising 3 formations all of Devonian age. The Gaspé sandstone, also named by Logan, is restricted to central Gaspé basin. It consists of 3 formations, comprising 8 members of Lower Devonian and Silurian age. Two Silurian formations, older than the Gaspé sandstone, contain species of Monograptus that permit correlation with the Silurian succession of Great Britain.--P. Harker.

2-573. Fong, George. GEOLOGY OF DEVONIAN BEAVERHILL LAKE FORMATION, SWAN HILLS AREA, ALBERTA, CANADA: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 2, p. 195-209, 6 illus. on pl., 5 maps, 5 secs., Feb. 1960, 24 refs.

Throughout most of W.-central Alberta, the Beaverhill Lake formation consists of interbedded dense limestones and shales, but in the Swan Hills area a productive unit of porous clastic and organic limestones, the Swan Hills member, is present near the base of the formation. This member contains an early Waterways fauna and represents early Beaverhill Lake reefing. At the western border of the type area, the Swan Hills member occupies the entire Beaverhill Lake interval and interfingers with dolomite beds underlying reefs of post-Beaverhill Lake Woodbend age. To date, all known hydrocarbons in the Beaverhill Lake formation are trapped in localized reef build-ups of the Swan Hills member, but the regional pinch-out edge of this member is only in the early stages of being explored for stratigraphic traps.--Auth.

2-574. Braun, Jordan C. A STRATIGRAPHIC STUDY OF THE SYCAMORE AND RELATED FORMATIONS IN THE SOUTHEASTERN ANADARKO BASIN: Shale Shaker, v. 10, no. 1, p. 6-7, 9-16, 18-23, 4 maps, secs., Sept. 1959, 57 refs.

The area of this study includes portions of Stephens, Carter, Murray, Garvin, Grady, and McClain counties in S.-central Oklahoma. Within this area the terms Mayes and Sycamore are used interchangeably by subsurface geologists. An attempt has been made to apply the time rock correlations of the most recent investigators to lithologies studied.

The interval referred to as "Sycamore limestone" in the Ardmore and Anadarko basins is too inclusive and should be restricted to the upper massive, silty to fine, sandy limestone herein referred to as the Sycamore formation. The age is probably Meramecian [Mississippian].

A "pre-Sycamore" sequence immediately underlying the Sycamore consists of alternating thin beds of silty dark limestone and gray fucoidal gritty shale. This sequence is referred in part at least, to the Kinderhookian series and herein termed the Welden formation [Mississippian]. The Welden formation of the Ardmore basin thins northeastward and is absent in the Anadarko basin. This thinning is due to transgressive overlap from the S. to the N.

Widespread usage of the term Mayes has long presented a problem to Oklahoma stratigraphers. The Mayes is here treated as a lower silty calcareous phase of the Caney formation [Mississippian]. The Mayes represents Meramec age and is possibly the Ahloso member of the Caney formation of recent investigators. Excluding the Mayes facies, the Caney shale is placed in the Chesterian series.

Major NW.-SE.-trending faults are believed to approximate the line of facies change between the Mayes and upper Sycamore. It is possible that the facies change was a zone of weakness along which post-Mississippian faulting occurred.

Present production from the Sycamore is either on or downdip from truncated surfaces, or on anticlinal trends where there is tight folding and faulting. Past production from the Sycamore has not been impressive but has nevertheless been commercial, and the formation should be considered carefully as a possibility in any future drilling program.--C. E. Branham.

2-575. Elias, Maxim K., and Carl C. Branson. TYPE SECTION OF THE CANEY SHALE: Oklahoma Geol. Survey, Circ. 52, 24 p., 2 maps, chart, 4 tables, 1959, 19 refs.

The Caney shale formation [Mississippian] is established in the region in which it was originally described by designating a type section in the Arbuckle Mountain area. Five measured sections in the adjacent ravines W. of Viola townsite are so designated, and type sections of 3 members are likewise established there. The original type locality is abandoned except as the source of the name, and the shales which there contain exotic boulders are left under the name Johns Valley shale.--Auth.

2-576. Desborough, George A. CORRELATION OF BOSKYDELL SANDSTONE IN SOUTHWESTERN ILLINOIS: Am. Assoc. Petroleum Geologists, Bull. v. 43, no. 11, p. 2720-2724, Nov. 1959, 11 refs.

The stratigraphic terminology of the Pennsylvania of southwestern Illinois is reviewed. The Boskydell sandstone lies above the Pounds sandstone (= lower massive Makanda) but not above the Grindstaff sandstone, and therefore below the Willis coal.

The Boskydell contains conspicuous amounts of small quartz pebbles and large quartz granules, a characteristic normally associated with the Caseyville group rather than with the Tradewater group.

The Boskydell sandstone contains poorly preserved marine fossils which were deposited more or less in situ. The entire Boskydell sandstone probably exceeds 30 ft. in thickness; the actual geographic extent of the Boskydell is not known.--I. M. Johnston.

2-577. Gunter, Craig E. SUBSURFACE STUDY OF THE DEESE GROUP, WESTERN GARVIN COUNTY, OKLAHOMA: Shale Shaker, v. 10, no. 2, p. 6-9, 11-17, 19, 8 maps, 4 secs., Oct. 1959, 22 refs.

The area included in this discussion is located principally in western Garvin County, or more specifically T. 2-4 N. and R. 2-5 W.

The base of the Second Checkerboard limestone marks the top of the Deese group [Pennsylvanian] and is correlative throughout the area. Correlations within the Deese group are best made by zoning. Five Deese zones are proposed, Abernathy, Pharoah, Gibson, Hart, and Osborne, each with a sand unit for which it is named. The lower 4 Deese zones pinch out by progressive onlap eastward on the Pauls Valley uplift. The unconformity overlying the Morrowan series marks the base of the Deese group. This surface greatly affected Deese sedimentation.

Major movements culminated in post-Morrow pre-Deese time. The Deese sediments were the initial deposits of the Anadarko basin. Sources of Deese sediments were probably the Pauls Valley and Hunton Tishomingo uplifts. Permeability limits Deese production basinward, as the sandstone becomes finer grained and shaly. Most future production will be obtained from pre-Deese horizons.--C. E. Branham.

2-578. Harlton, Bruce H. STRATIGRAPHY OF CEMENT POOL AND ADJACENT AREA, CADDO AND GRADY COUNTIES, OKLAHOMA: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 2, p. 210-226, 3 maps, chart, 5 secs., Feb. 1960, 11 refs.

The surface structure of Cement is more or less a symmetrical fold with 2 well-defined domes. Since the early development which followed the drilling of the discovery well in 1916, exploration has been guided mainly by subsurface geological work. The discovery well, located on the crest of the anticline, was a producer from the Garber sandstone of Permian age.

Most of the nomenclature of the Cement field took partial form in 1939 and 1940 when production was developed in the Rowe and Marchand sandstones. Though the correlations and identifications of the lithologic units involved have been generally known and accepted, it is obvious that the nomenclature now being used should be standardized. The boundaries of the Cisco, Missouri, Des Moines, and the Atoka are herein established on the basis of fusulinid determinations.

The old field, about 16 mi. in length, is a structural accumulation of a NW.-SE.-trending anticlinal axis. An interesting structural feature of the field is the well-defined fault on the N. flank. Structurally high and low fault blocks are fundamental features of the axis.--Auth.

2-579. Eliseeva, V.K. STRATIGRAPHY AND PALEOGEOGRAPHY OF THE CARBONIFEROUS AND PERMIAN FORMATIONS OF SIKHOTE-ALIN. Translated by Research International: Internat. Geology Rev., v. 1, no. 12, p. 1-20, 3 maps, 2 secs., table, Dec. 1959, 40 refs.

The region now represented by the Sikhote-Alin range was a geosyncline during the Carboniferous and Permian periods. On the basis of structure and petrology, 4 zones can be distinguished within the area. These are the Olga-Tetyukhinsk, central Sikhote-Alin, southern-coastal, and Grodekovsk zones. In the Olga-Tetyukhinsk zone the Permo-Carboniferous section consists of 8,000 m. of sandstone interbedded with shale, chert, and limestone, and in the central Sikhote-Alin zone, it is composed of 14,000 m. of terrigenous sediments interbedded with basic and intermediate volcanic rocks. In the marginal southern coastal zone, the upper Paleozoic sequence, predominantly of continental origin, records repeated uplift and subsidence. An abundant flora indicates continental conditions to have prevailed in the Grodekovsk zone during early Permian time; upper Permian formations are marine, commonly of limestone with interbedded tuff and lava.--Translator.

2-580. Silberling, Norman J. PRE-TERTIARY STRATIGRAPHY AND UPPER TRIASSIC PALEONTOLOGY OF THE UNION DISTRICT, SHOSHONE MOUNTAINS, NEVADA: U.S. Geol. Survey, Prof. Paper 322, 67 p., 9 illus., 2 maps (col. geol. map, scale 1:24,000, in pocket), 2 charts, sec. (in pocket), 1959, 59 refs.

A nearly complete section of uppermost Paleozoic and lower Mesozoic rocks aggregating more than 9,000 ft. in thickness is exposed in the Union district. In ascending order this section includes: the Pablo formation of andesitic volcanic and clastic rocks and subordinate limestone of Permian(?) age; the Grantsville formation comprising a lower clastic member and an upper limestone member with an upper Middle Triassic fauna; the Luning formation which is predominantly carbonate rock except for a basal clastic member and which contains ammonite faunas of late Karnian and Norian (Late Triassic) age; and a conformable sequence of marine calcareous, argillaceous, and silty rocks of latest Triassic to late Early Jurassic age assigned to the undifferentiated Gabbs and Sunrise formations, and sandy, possibly nonmarine, rocks assigned to the Dunlap formation.

A thick unit of quartzite and another of dolomite, tentatively assigned to the Cambrian, occupy a small part of the area in unknown relation to the younger pre-Tertiary rocks.

The pre-Tertiary rocks have been deformed by large-scale folding with subsidiary thrusting, and by a complex pattern of younger normal faults.

Twenty-one species of Upper Triassic marine mollusks, including 10 new species, are described under the following genera: of ammonites, Klamathites, Mojsisovicsites, Tropites, T. (Anatropites), Tropiceltites?, Guembelites, and Discophyllites; of nautiloids, Clydonautilus, Germanonautilus, and Phloioceras; and of pelecypods, Myophoria and Septocardia?.--Auth.

2-581. Young, Robert G. DAKOTA GROUP OF COLORADO PLATEAU: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 2, p. 156-194, 3 illus., 9 maps, chart, 7 secs., 4 tables, Feb. 1960, 56 refs.

Basal Cretaceous deposits of the Colorado Plateau can be subdivided into 2 formations on the basis of carbonaceous content. The lower noncarbonaceous unit, the Cedar Mountain formation, consists of mudstones and persistent conglomeratic sandstones which were deposited in an inland floodplain environment. The upper carbonaceous unit, the Naturita formation, consists of carbonaceous mudstone, coal, persistent conglomeratic sandstones, and beach sandstones deposited on or adjacent to the shore of the Mancos sea. Naturita deposits can be traced landward into Cedar Mountain deposits, indicating that they are facies of a larger unit, the Dakota group.

Advancing Cretaceous seas reached the eastern

edge of the plateau in late Albian time but did not inundate the entire plateau until late Greenhorn or early Carlile time. The westward advance of the sea was a halting one. Sharp pulses of basinal subsidence, accompanied by uplift in the source area W. of the plateau, resulted in rapid westward transgressions of the sea. Deposition, essentially confined to periods of quiet following the transgressions, caused some regression of the sea, but transgressions exceeded the regressions and resulted in a slow westward advance of the sea. Many pulses of subsidence occurred, but 5 major ones, which were accompanied by uplift in the source area, are reflected in the 5 widespread orogenic sandstones present in these deposits.--Auth.

2-582. Hall, Charles A., Jr., David L. Jones, and Stephen A. Brooks. **PIGEON POINT FORMATION OF LATE CRETACEOUS AGE, SAN MATEO COUNTY, CALIFORNIA:** Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 12, p. 2855-2859, 2 maps, Dec. 1959, 11 refs.

Upper Cretaceous beds near the town of Pescadero in San Mateo County are named the Pigeon Point formation. The Pigeon Point crops out in a belt less than 2 mi. wide which extends from Pescadero Point S. to midway between Franklin Point and Año Nuevo Point, a distance of approximately 10 mi. The rocks exposed in the coastal cliffs in the above area constitute the type section.

The thickness of the formation probably exceeds 8,500 ft. The beds consist mainly of brown and greenish gray sandstone with some siltstone, mudstone, and conglomerate. On the basis of mollusks, including ammonites, and Foraminifera, the Pigeon Point formation is in part Campanian in age and probably younger.

In no way - fauna, lithology, thickness or age - does the Pigeon Point resemble the type Chico formation.--I. M. Johnston.

2-583. Berryhill, Henry L., Jr., Reginald P. Briggs, and Lynn Glover, 3d. **STRATIGRAPHY, SEDIMENTATION, AND STRUCTURE OF LATE CRETACEOUS ROCKS IN EASTERN PUERTO RICO - PRELIMINARY REPORT:** Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 2, p. 137-155, 8 maps, chart, 4 secs., Feb. 1960, 20 refs.

Rocks of Late Cretaceous age (Turonian to Maestrichtian) in Puerto Rico are of 3 types: 1) primary volcanic rocks, including tuffs, tuff breccias, and lavas; 2) intermixed pyroclastic and epiclastic rocks, including volcanic conglomerates, volcanic sandstones, and volcanic siltstones; and 3) limestones, most of which were formed as reefs around volcanic islands. These rocks, which have a maximum thickness of more than 20,000 ft., crop out along the crest and flanks of a complexly faulted, northwestward-trending anticlinorium that forms the mountainous core of Puerto Rico.

In the central and S. -central parts of the Commonwealth 3 formations are recognized. The Robles formation, which probably ranges from late Coniacian to early Campanian in age, is characterized by laminated siltstones and sandstones but includes the Lapa and Las Tetas lava members and locally at the base the rudistid-bearing Río Matón limestone member. The Cariblanco formation, which unconformably (?) overlies the Robles formation, is probably middle Campanian to middle Maestrichtian in age. It is made up predominantly of thick coarse conglomerates separated by snadstones and siltstones. The Coamo formation of late Maestrichtian age consists chiefly of massive tuff breccias and bedded tuffs including ashflow deposits.

In northeastern Puerto Rico the Upper Cretaceous section consists of the Fajardo formation, chiefly siliceous, ammonite-bearing mudstones and siltstones of Turonian and Coniacian age; interbedded sandstones, siltstones, thin limestones, pebble conglomerates, and tuff breccias that are believed to be equivalent to the Robles and Cariblanco formations of S. -central Puerto Rico; and conglomerates, sandstones, and lenticular reef limestones that are believed to be equivalent to the Coamo formation. Rocks equivalent to the Fajardo formation in the central part of the island consist of massive volcanic breccias, lavas, thin tongues of sandstone, and the Aguas Buenas limestone member, a reef deposit that lies at the base of the Fajardo formation.

From N. -central Puerto Rico eastward the upper part of the Robles formation is represented by a thick sequence of pillow lavas and by volcanic breccia and agglomerate that appear to have accumulated along a W. -northwestward-trending belt of volcanism.

The strata of known Late Cretaceous age overlie massive volcanic rocks whose age has not been determined. They are conformably overlain in most places by strata probably Paleocene and Eocene in age, but are locally overlain unconformably by limestones of Oligocene age.

Rocks of the Fajardo, Robles, and Cariblanco formations and their probable equivalents are chiefly subaqueous, stratified deposits that accumulated in a subsiding basin adjacent to volcanic source areas. Cross-bedding is rare in all of these rocks, but graded bedding, cyclic repetition of unsorted coarse clastics and fine-grained clastics, and slump structures indicate that turbidity currents were an important agent in the transportation and deposition of the debris. The Coamo formation, characterized by redbeds, consists chiefly of subaerial deposits including tuffs and tuff breccias. Some of the Coamo formation tuffs were transported and redeposited by mudflows or lahars, others are ashflow or hot, avalanche deposits.

The present anticlinal structure of the Late Cretaceous rocks is believed to be the result of doming during intrusion of a batholith during early Tertiary time. Complex faulting that accompanied the batholithic intrusion in places helped to accentuate the anticlinal structure but in other places has modified it. Faulting has been most intensive in a belt that trends W. -northwestward across the central part of the island. Normal, high-angle reverse, and transcurrent faults are recognized, but the principal fault of northern Puerto Rico appears to be a transcurrent fault of regional extent.--Auth.

2-584. Durrell, Cordell. **TERTIARY STRATIGRAPHY OF THE BLAIRSDEN QUADRANGLE, PLUMAS COUNTY, CALIFORNIA:** California, Univ., Pubs. Geol. Sci., v. 34, no. 3, p. 161-192, 12 illus., on 6 pls., 5 maps, chart, 1959, 22 refs.

The Tertiary rocks of the Blairsden quadrangle are divided into 8 formations, which are, in order of decreasing age: the Auriferous gravels, the Lovejoy, Ingalls, Delleker, Bonta, and Penman formations, the Warner basalt, and the Mohawk Lake beds; all but the first and the last 2 names are new. The formations range in age from middle Eocene to Plio-Pleistocene, and each is separated from the one below by an unconformity that resulted from faulting

and erosion.

All but the youngest and oldest are volcanic in origin. The Lovejoy and the Warner are sequences of basalt lavas, the Ingalls, the Bonta, and the Penman are of andesite mudflow breccia, conglomerate, fanglomerate, and tuff, and the Delleker is rhyolite tuff.

The Auriferous gravels were confined to a river valley, as was the Lovejoy, but the 2 valleys were not the same. The others, except the Mohawk Lake beds, were deposited as sheets of wide extent. The Mohawk Lake beds, and correlative deposits in other similar fault basins, were of restricted extent.

Material was transported from the NE. quadrant to the SW. during nearly all of Tertiary time. The Sierra Nevada did not assume its present form until after the eruption of the Warner basalt, when the drainage from the interior was cut off along the rising scarp that marks the eastern edge of the range. --Auth.

2-585. Durrell, Cordell. THE LOVEJOY FORMATION OF NORTHERN CALIFORNIA: California, Univ., Pubs. Geol. Sci., v. 34, no. 4, p. 193-219, 2 illus. on pl., 4 maps, 1959, 22 refs.

Basalt lavas of Tertiary age in Plumas, Butte, Tehama, and Solano counties, and beneath the Sacramento Valley both N. and S. of Sutter Buttes, have been previously assigned tentatively to various ages, mostly Pliocene.

The principal occurrences extending from near Honey Lake in Lassen County to Orland Buttes in Tehama County and to Putnam Peak, near Vacaville, in Solano County, have been studied in the field, and a large collection of samples have been examined microscopically. Cuttings from 3 wells in the Sacramento Valley have also been studied.

The megascopic aspects of the basalts at all occurrences are virtually identical. Microscopically the rocks are distinctive, in respect to the nature of a mesostasis, which is of 2 principal types and 7 subtypes. Most of the subtypes are found at all principal occurrences.

It is concluded that all described occurrences of these rocks are parts of a once continuous sheet of lava called the Lovejoy formation. It is suggested, as a hypothesis, that the lavas were erupted E. of the Honey Lake fault scarp and that magma flowed SW. through a broad valley to the Sacramento Valley.

The age of the Lovejoy formation is established as upper Eocene or lower Oligocene, based on its stratigraphic position, and the occurrence of Lovejoy basalt reworked into beds below the upper Eocene or lower Oligocene tuff at La Porte, Plumas County, California.--Auth.

2-586. Glen, William. PLIOCENE AND LOWER PLEISTOCENE OF THE WESTERN PART OF THE SAN FRANCISCO PENINSULA: California, Univ., Pubs. Geol. Sci., v. 36, no. 2, p, 147-197, 24 illus., on 3 pls., 3 maps, sec., 1959, 47 refs.

The type Merced formation, approximately 5,000 ft. thick, is mostly gray and brown, soft, friable sandstone and was largely deposited in a marine, shallow-water, coastal embayment environment. Forty-nine molluscan and 2 crustacean species indicate deposition from middle Pliocene through early Pleistocene time. Some of the sediments were deposited in fresh water, at least locally, in the early Pleistocene.

Fossils and lithology indicate that the "Merced" formation of Pillar Point is of middle Pliocene age and a part of the Purisima formation. Only a small part may be correlative with the type Merced formation.

The Purisima formation at Piller Point ("Merced" formation) is lithologically and faunally separable into 2 parts. N. of the Seal Cove fault, highly indurated sandstones and conglomerates and soft sandstones contain a shallow-water fauna suggesting a brackish-water environment during deposition of these younger beds; S. of the Seal Cove fault, well-indurated siltstones, mudstones, and shales bear an upper bathyal fauna. Marine mammals and 29 species of mollusks, including a new Spisula, are recorded from the "Merced" formation of Pillar Point.--Auth.

2-587. Du Bar, Jules R. THE WACCAMAW AND CROATAN DEPOSITS OF THE CAROLINAS: South Carolina, State Devel. Board, Div. Geology, Geol. Notes, v. 3, no. 6, p. 1-9, table, Nov.-Dec. 1959, 18 refs.

The Waccamaw and Croatan formations along with the Caloosahatchee marl of Florida have been considered more or less contemporaneous deposits, representing the type marine Pliocene of eastern United States. Recently the Caloosahatchee marl has been proved to be Pleistocene in age. Re-evaluation of the Pliocene age assignment of the Waccamaw and Croatan formations thus has become necessary. Geologists supporting a Pliocene age for the Waccamaw and Croatan formations have given much weight to the following criteria: 1) the assumption that the Waccamaw and Croatan are overlain by early Pleistocene deposits, and underlain by late Miocene formations, which literally forces these formations into the Pliocene; 2) Lyellian molluscan percentage method; 3) comparative faunal studies of various Neogene formations.

The present study points out that the Waccamaw and Croatan formations are apparently overlain by late Pleistocene rather than early Pleistocene deposits; therefore, stratigraphic position does not necessarily dictate a Pliocene age for these formations. The Lyellian percentage method has been long discredited as a precise method of age determination. Faunal comparative studies are generally a reliable approach to age determination. Unfortunately, past conclusions, mainly by William H. Dall, were based heavily on the erroneous assumption that the true stratigraphic ranges of most of the molluscan species were accurately determined.

It is concluded that a Pliocene age for the Waccamaw and Croatan deposits has not been proved, that there is at least as much reason to classify these formations as Pleistocene in age, but that there seems to be no support for suggested Miocene assignment. --Auth.

2-588. Wang, Yun-sheng, Hu Huei-min, and Lee Sheng-lin. CONTRIBUTIONS TO THE AGE AND ORIGIN OF THE SAN-MEN SERIES. Translated by Royer & Roger, Inc.: Internat. Geology Rev., v. 1, no. 12, p. 40-55, map, 9 secs., table, Dec. 1959, 10 refs.

New information on the San-men series of northern China has resulted from studies made in connection with the construction of the San-men gorge reservoir. The San-men sediments are predominantly lacustrine, partly fluviatile and deltaic. The environment of deposition was a lake controlled by the Wei-ho, Fen-ho, and Yellow River grabens. The San-men differs lithologically and structurally from

underlying Tertiary beds. Early Pleistocene molluscs and vertebrate fossils have been identified.--M. Russell.

2-589. Cheetham, Alan H. TIME, MIGRATION, AND CONTINENTAL DRIFT: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 2, p. 244-251, 3 maps, chart, 7 tables, Feb. 1960, 17 refs.

Though the North Atlantic Ocean is a barrier to migration, interchange of warm-water shelf benthos between North America and Europe was a not unusual event in Tertiary time. Possible explanations for this are: 1) nearness of North America and Europe before they drifted apart later in the Cenozoic; 2) bridging of the North Atlantic by a continuous warm-water shelf; or 3) sweepstakes dispersal by currents, eastward across the northern Atlantic and westward nearer the equator.

Tertiary cheilostome bryozoans are particularly suitable for testing these hypotheses because, although they are among the least mobile marine invertebrates they include types known to attach to seaweed and other floating objects. Data concerning resemblance, time and place of origination, and rate and direction of migration of middle Eocene to Oligene faunas seem to harmonize best with the sweepstakes hypothesis of trans-Atlantic dispersal.--Auth.

2-590. Gastil, Gordon. THE DISTRIBUTION OF MINERAL DATES IN TIME AND SPACE: Am. Jour. Sci., v. 258, no. 1, p. 1-35, 3 maps, 2 charts, graph, 3 tables, Jan. 1960, 144 refs.

Most igneous and metamorphic mineral dates indicate times of rock cooling, the terminal events of crustal adjustments. Accordingly, the distribution of mineral dates in time indicates the periodicity of such events, and the distribution in space indicates the geometry of their occurrence. By this we may test the validity of such concepts as "orogenic periodicity," "cyclic orogeny," and "continental accretion."

A plot of mineral date abundance against age shows that crustal adjustments are periodic and roughly cyclic. Intervals for which abundant mineral dates have been preserved are about 175 to 250 million years in length, with cycles of about 350 to 500 million years. Intervals of date abundance fall in the ranges: -2710 to -2490 m.y., -2220 to -2060 m.y., -1860 to -1650 m.y., -1480 to -1300 m.y., -1100 to -930 m.y., -620 to -280 m.y., and -120 to the present.

Mineralogenic events of very different ages are commonly recorded in the same area, not infrequently in the same rock. Large areas, however, can be characterized by the mineral dates of the last interval of mineralogenic activity by which they were seriously affected. In North America these mineralogenic provinces show a crudely concentric pattern, younger dates outward. Similar arrangements have not been found in other continents.--Auth.

2-591. U.S. Atomic Energy Commission. VARIATIONS IN ISOTOPIC ABUNDANCES OF STRONTIUM, CALCIUM, AND ARGON AND RELATED TOPICS: Its: [Pub.] NYO-3938, 228 p., 3 illus., 8 maps (2 fold.), 5 diags., graph, approx. 30 tables, March 1958, 258 refs.

Individual reports outline the beginning stages of investigations of world-wide age correlations of the Precambrian in Australia, South Africa, Brazil, Venezuela, Colombia, the southern Atlantic states, islands in the Caribbean, the northern Appalachian province, Nova Scotia, Newfoundland, and the Canadian Shield area including Labrador.

The most interesting observation during the year has been the increase of localities in different continents that have been found to show similar age groupings. The 2,600 million years age has now appeared in Ontario, Quebec, the Northwest Territories (Yellowknife belt), Karelia, S. and central Africa, India, Australia, and Brazil. The 1,700 m. y. age (±100 million years) is appearing in northern Manitoba, S. Greenland, central Fennoscandia, the metamorphic belt involving the Huronian sections of the Great Lakes region extending from the Sudbury district into Minnesota, at least parts of Labrador, India, central Africa, and the Northern Territory of Australia. Similar statements may be made regarding the typical Grenville age of about 1,000 m. y. and the typical latest Precambrian age in the vicinity of 500 m. y.

Another observation, first noted by Arthur Holmes, is that by far the greatest proportion of the world's Au production comes from the 2,600 million year old provinces. These include the Au mines of Ontario and Quebec, the Yellowknife district in the Northwest Territories, Mysore and Kolar Au fields in India, Kalgoorlie and other Au fields in Western Australia, the ancient crystalline source area of the Witwatersrand Au district in South Africa, and now a possibility of the Au region in Minas Gerais, Brazil. There must be a good geological explanation for this strong association.

Another observation has been that the range of ages from 300-400 m. y. found in Nova Scotia seems to agree with a similar range across the Piedmont in Georgia and in southern New England. The age of the post lower-Middle Devonian intrusives, where stratigraphic relationships are observed, must therefore be measured individually, rather than be determined from an average for the belt as a whole. --From foreword.

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Age Measurement Program in the Northern Appalachian Province, p. 61-68, 6 refs.

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Winchester, J. W., and others. Radiochemical Studies, p. 70-76.

Herz, Norman, and J. V. N. Dorr, 2d. (collaborators). Program of Age Measurements in the Brazilian Shield, p. 77-81.

Pinson, W. H., Jr., L. F. Herzog, H. W. Fairbairn, and R. F. Cormier. Sr/Rb Age Study of Tektites, p. 82-96, 16 refs.

Schurmann, H. M. E. (collaborator). Preliminary Age of the Dara Granite, Older Gattarian Plutonics, East of the Nile in Egypt, p. 97-98, 3 refs.

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Cahen, L. S. (collaborator). Plans for the African Program, p. 103-106.

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Initial Investigations Leading to a Study of Sr^{87} Variations in the Crust and Mantle, p. 129-131.

Collection of Glauconite from Known Stratigraphic Horizons for the Dating of the Geologic Time Scale, p. 132-166.

Gheith, Mohamed A. Tabulated Index and Bibliography of Published Age Measurements of North America, p. 167-228, 209 refs.

2-592. Faul, Henry, Emilie Jäger, R.H. Robinson, and H.H. Thomas. POTASSIUM-ARGON PROJECT REPORT FOR THE YEAR 1958-1959: U.S. Geol. Survey, Repts., Open-File Ser., no. 489, 8 p., tables, 1959.

All the numerical data obtained during the year are arranged topically by area. All analyses were made on biotite concentrates except for a few marked specifically otherwise. Examination of the following points gave the ages listed (in million years):

Post-early Permian intrusion (Oslo region)	260 m.y. 260 m.y.	(K/Ar) (zircon, isotopic)
Early Mississippian intrusions (Vosges)	340 m.y. 315 m.y.	(Sr/Rb) (K/Ar)
Late Devonian "Hass bed" - a biotite-bearing bentonite marker in the Chattanooga shale (Tennessee)	340 m.y.	(K/Ar)
Post-Middle Devonian intrusion (Katahdin area, Maine)	360 m.y.	(K/Ar)
Post-Middle Devonian intrusion and metamorphism (Jackman area, Maine)	360 m.y.	(K/Ar)
Post-Silurian, pre-Late Devonian intrusions (eastern Maine)	400 m.y.	(K/Ar)
Middle Ordovician volcanic tuff, biotite-bearing (Alabama)	420 m.y.	(K/Ar)

--M. Russell.

2-593. Giffin, C.E., and J. Laurence Kulp. POTASSIUM-ARGON AGES IN THE PRECAMBRIAN BASEMENT OF COLORADO: Geol. Soc. America, Bull., v. 71, no. 2, p. 219-222, 2 maps, table, Feb. 1960, 8 refs.

From this survey the following conclusions are reached:

1) Further reconnaissance of the Precambrian basement of Colorado by the K-Ar method has not detected rocks older than 1,500 million years.

2) A major orogenic event may have occurred about 1,500 m.y. ago in the area of Colorado which either produced the initial basement or recrystallized it to such an extent that no inherited radiogenic Ar was preserved.

3) A less intense metamorphic-igneous event occurred at about 1,000 m.y. ago which caused loss of inherited radiogenic Ar in the granites and metamorphic rocks of the Pikes Peak area and many have been accompanied by the intrusion of the St. Peters Dome pegmatite swarm. This event is clearly detected in small areas as far W. as the Black Canyon of the Gunnison and N. to the Wyoming border near Northgate, Colorado.

4) All K-Ar ages in Colorado can be most simply accounted for by assuming only these 2 events. The data, however, do not preclude additional thermal pulses between 1,000 and 1,500 m.y. ago or that the original basement is older than 1,500 m.y.

5) The presently exposed Precambrian basement of Colorado does not appear to have been subject to significant metamorphic activity since about 1,000 m.y. ago.

Further investigations of this area are in progress.--Auth. concl.

2-594. Aldrich, L.T., and G.W. Wetherill. Rb-Sr AND K-A AGES OF ROCKS IN ONTARIO AND NORTHERN MINNESOTA: Jour. Geophys. Research, v. 65, no. 1, p. 337-340, map, 2 tables, Jan. 1960, 9 refs.

Analyses of micas from 7 localities in southern Ontario with previously published data broadly outline the area of the oldest rocks in the Canadian Shield. The ages as determined by both the Rb-Sr and K-A methods range from 2,500 to 2,650 million years.--Auth.

2-595. Hayden, Richard J., and John P. Wehrenberg. A^{40}-K^{40} DATING OF IGNEOUS AND METAMORPHIC ROCKS IN WESTERN MONTANA: Jour. Geology, v. 68, no. 1, p. 94-97, table, Jan. 1960, 6 refs.

A^{40}-K^{40} dates, obtained by the use of the isotope dilution method, are reported for a number of occurrences of igneous and metamorphic rocks from western Montana.--Auth.

5. PALEONTOLOGY

See also: Stratigraphy 2-580, 2-586, 2-589.

2-596. Briggs, Michael H. DATING THE ORIGIN OF LIFE ON EARTH: Evolution, v. 13, no. 3, p. 416-418, Sept. 1959, 15 refs.

The earliest fossils, or traces of biological material presently detectable, are older than 2 billion years; the oldest are simple algae from Southern Rhodesian limestone dated about 2.7 billion years. Theoretical studies of the supposed primitive atmosphere of the earth and the oxidation state of Fe in rocks indicate that O has been a component in the atmosphere for a similar period. Complex chemical systems, such as algae and bacteria, apparently capable of photosynthesis, were present over 2 billion years ago.--M. Russell.

2-597. Olson, Everett C. THE EVOLUTION OF MAMMALIAN CHARACTERS: Evolution, v. 13, no. 3, p. 344-353, chart, Sept. 1959, 13 refs.

The patterns of evolution of the mammalian predecessors and an interpretation of these is followed by a discussion of the independent development of

mammallike characters in the various evolving lines of therapsids. During the upper Carboniferous there was an adaptive shift from a primitive captorhinomorph, involving both herbivorous, and carnivorous forms. This was followed by adaptive radiation of the pelycosaurs with the development of advanced ophiacodonts, sphenacodonts, caseids, and edaphosaurids. In the Permian there was a transition from sphenacodont pelycosaurs to therapsids, both herbivorous and carnivorous forms. In the Lower Triassic advanced therapsid radiation included a continuing acquisition of mammallike characters. The transition from reptiles to mammals took place in the Rhaetian or Liassic, and its most striking feature is the independent acquisition of mammallike characters by various therapsid lines. Natural selection tended toward the mammalian condition in all lines of therapsids, and full attainment of the physiological characteristics of the primitive mammals was apparently reached by several of these lines. Taxonomic convenience determines to a large degree any decision on whether to include the transition-stage animals in the mammals or the reptiles; thus if some genus ties in most logically with developing lines generally recognized as mammalian it should be placed in the mammals but if it ties in more readily with some group of reptiles which appears to have led up to it, it should be placed with the reptiles. Presumably there must exist genera on which the decision can only be determined by flipping a coin, unless a more drastic modification of class structure than now seems desirable is accepted.--M. Russell.

2-598. Simpson, George Gaylord. MESOZOIC MAMMALS AND THE POLYPHYLETIC ORIGIN OF MAMMALS: Evolution, v. 13, no. 3, p. 405-414, Sept. 1959, 30 refs.

The evidence for the theory of the polyphyletic origin of mammals is reviewed, forms from Late Cretaceous back through the Middle Jurassic being cited first. The problem of what constitutes an adequate paleontologic definition of a mammal is discussed; the inadequacy of the heretofore acceptable diagnoses based on 4 specific points concerning the articulation of mandible and skull and associated osteological features is illustrated by reference to several animals which are reptile according to some of the criteria but mammal according to others. The Class Mammalia is concluded to be a grade and not a clade. Of several possible alternatives for resolving the resultant problems of principle for formal taxonomy the following is preferred. The groups known to have reached mammalian grade may be retained as a phylogenetically based Class Mammalia on the following principles. Evolutionary classification does not express phylogeny but is based on phylogenetic interpretation of observed data. It is necessary to compromise between horizontal and vertical separation of taxa. That each taxon sometime included only one species in its ancestry should be true, but it is a completely impractical requirement that each taxon be so delimited and defined as to include and begin with that species. It is a sufficient principle that each taxon arose wholly from one of lower categorical level, as Class Mammalia from Order Therapsida.--M. Russell.

2-599. Wood, Albert E. EOCENE RADIATION AND PHYLOGENY OF THE RODENTS: Evolution, v. 13, no. 3, p. 354-361, chart, diag., Sept. 1959, 21 refs.

Classification of the Order Rodentia must be considered tentative until such problems as parallelism are resolved. The major branchings within the order based on current knowledge of the Eocene rodents and their history is presented. It seems probable, if not demonstrated, that: 1) the Paramyidae were the ancestral family of rodents, and probably included all Paleocene rodents; 2) from the Paramyidae there developed in the Eocene, a radiation of Protrogomorpha, forms in which the masseter remained primitive; 3) the middle to late Eocene radiation gave rise to the sciuromorphous, myomorphous, and hystricomorphous types of rodents, each of which seems to have developed independently more than once; 4) the superfamilial grouping of the order is complex, and the details are a long way from being clearly worked out. Certainly, however, the 3 classical suborders cannot be stretched to include all rodents; and 5) in view of all the parallelism that has taken place during the evolution of the rodents, the only way that a firm classification can be developed is by understanding the phylogeny of all the families involved. --M. Russell.

2-600. Flügel, Erik. HETERASTRIDIUM CONGLOBATUM CONGLOBATUM REUSS, AN UPPER TRIASSIC HYDROZOAN FROM THE PETRA-TOU-ROUMIOU LIMESTONE OF PENDAKOMO, CYPRUS: Jour. Paleontology, v. 34, no. 1, p. 127-132, 2 illus. on pl., Jan. 1960, 31 refs.

The hydrozoan Heterastridium conglobatum conglobatum Reuss is described from the Petra-tou-Roumiou limestone of southern Cyprus. The Pendakomo locality may be Carnic(?) or Noric in age, for Heterastridium is known only from these stages of the Tethyan Upper Triassic. A brief review of the distribution and stratigraphic range of Heterastridium Reuss and a glossary of the skeletal morphology is included.--Auth.

2-601. Oliver, William A., Jr. RUGOSE CORALS FROM REEF LIMESTONES IN THE LOWER DEVONIAN OF NEW YORK: Jour. Paleontology, v. 34, no. 1, p. 59-100, 7 pls., map, 34 graphs, 8 tables, Jan. 1960, 66 refs.

A new rugose coral fauna from a previously undescribed reef facies of the Coeymans limestone of early Early Devonian age in New York consists of 9 species, all new, assigned to 6 genera, 3 new. Collections are from 9 separate reefs or reef areas in which individual reef-knobs average 100 ft. in diameter and 20 ft. in height. The fauna is peculiar in that most of the species are characterized by partial or complete stereoplasmic filling of the corallum. In this respect it finds a close analogue in the Koneprus limestone of Bohemia (also a reef facies) but the genera in the 2 faunas are not closely related. Two of the species seem to be early representatives of characteristic later genera of Onondaga age, but the phylogenetic relationships of the other species are not clear.

Individual variation in 8 of the described species is expressed in standard statistical terms and illustrated by means of scatter diagrams, frequency curves, and average valve curves. In the species studied the septal ratio (number of major septa/diameter) decreases with increasing diameter both among adults and in ontogeny. The tabularium ratio (tabularium diameter/diameter) is constant with increasing diameter among adults but ontogenetically shows a marked decrease with increasing diameter. Variation within colonies of Tryplasma fascicularium is

of the same magnitude as variation within populations of solitary cylindrical corals but the conical species show much greater variation.--Auth.

2-602. Stumm, Erwin C. NEW RUGOSE CORALS FROM THE MIDDLE AND UPPER DEVONIAN OF NEW YORK: Jour. Paleontology, v. 34, no. 1, p. 161-163, pl., Jan. 1960, 11 refs.

Two new species of rugose corals, Macgeea ponderosa and Mictophyllum orientalis are described from the Chemung group. The new species Depasophyllum tabulatum is described from the Tully limestone.--Auth.

2-603. Stensaas, L. J., and R. L. Langenheim, Jr. RUGOSE CORALS FROM THE LOWER MISSISSIPPIAN JOANA LIMESTONE OF NEVADA: Jour. Paleontology, v. 34, no. 1, p. 179-188, 12 illus., map, sec., Jan. 1960, 12 refs.

Kakwiphyllum dux Sutherland and Lithostrotionella jasperensis Kelly are described from the Lower Mississippian Joana limestone at Ward Mountain, White Pine County, Nevada, and from other localities in E.-central Nevada. Their presence suggests biostratigraphic correlation between the Joana limestone and parts of the Banff and Rundle formations of western Canada.--Auth.

2-604. Nelson, Samuel J. MISSISSIPPIAN LITHOSTROTIONID ZONES OF THE SOUTHERN CANADIAN ROCKY MOUNTAINS: Jour. Paleontology, v. 34, no. 1, p. 107-126, 5 pls., map, 2 charts, Jan. 1960, 28 refs.

Lithostrotionid species of the Banff, Livingstone, Mount Head, and Etherington formations of the southern Canadian Rocky Mountains are described and arranged according to zones. In ascending order zonation is: the Lithostrotionella jasperensis zone of the upper part of the middle member; and the Lithostrotionella micra and Lithostrotion mutabile zones of the upper member of the Banff (Shunda); the Lithostrotion sinuosum zone of upper Livingstone; the Lithostrotionella bailliei n. sp. and L. astraeiformis zones of lower Mount Head, the Lithostrotion whitneyi zone of middle and upper Mount Head; the L. arizelum zone of uppermost Mount Head; the L. genevievensis zone of lower Etherington; and the Lithostrotionella stelcki n. sp. zone of upper Etherington.--Auth.

2-605. McGugan, A. A NEW SPECIES OF THE PELECYPOD MEGALODON FROM THE PERMO-CARBONIFEROUS OF THE BANFF AREA, ALBERTA: Jour. Paleontology, v. 34, no. 1, p. 101-106, pl., map, 3 secs., Jan. 1960, 24 refs.

A pelecypod from Exshaw Creek, Banff, Alberta, is referable to the genus Megalodon Sowerby and is given the new specific name M. banffensis. Although common in Europe, Megalodon is rare in North America and has not been previously recorded from western Canada.--Auth.

2-606. Leonard, A. Byron, and Tong-Yun Ho. A NEW SPECIES OF CALIPYRGULA (HYDROBIIDAE) FROM THE PLEISTOCENE OF TEXAS: Nautilus, v. 73, no. 3, p. 110-113, pl., Jan. 1960, 2 refs.

Calipyrgula pecosensis n. sp. (Mollusca: Gastropoda) is based on more than 1,000 specimens from 6 localities in late Pleistocene terrace deposits exposed along Pecos River in Pecos, Ward, and Crane counties, Texas. The associated invertebrates and fine, well-sorted lithology suggest a habitat in marshes or sluggish streams. Assignment to Calipyrgula is somewhat arbitrary, and discontinuities are noted in the recorded spatial and temporal distribution of that genus.--J. W. Valentine.

2-607. Bergenhayn, J. R. M. CAMBRIAN AND ORDOVICIAN LORICATES FROM NORTH AMERICA: Jour. Paleontology, v. 34, no. 1, p. 168-178, illus., Jan. 1960, 7 refs.

Five new species, 1 new genus and 1 new family of late Cambrian and early Ordovician loricates are described. The new family Preacanthochitonidae contains the new genus Preacanthochiton with the new species P. cooperi, P. depressus and P. productus. In addition the new species Chelodes intermedius and C. depressus are described. Although the collection consists of separated plates, a formula is developed that gives a close approximation of the length of the complete animal. The morphological and systematic discussions are followed by general remarks on the origin and evolution of the loricates. A preliminary synoptical table of the class Loricata and a list of references completes the paper.--Auth.

2-608. Gordon, MacKenzie, Jr. SOME AMERICAN MIDCONTINENT CARBONIFEROUS CEPHALOPODS: Jour. Paleontology, v. 34, no. 1, p. 133-151, 3 figs., 2 pls., Jan. 1960, 38 refs.

Studies of Carboniferous cephalopods, principally from Arkansas, but also from Kentucky, Indiana, Oklahoma, Texas, and Utah, have resulted in the recognition of 6 new genera: Reticycloceras (type species, R. croneisi, n. sp.) and Mitorthoceras (type species, M. perfilosum, n. sp.) which are orthoconic nautiloids, and Paracravenoceras (type species, P. ozarkense, n. sp.), Fayettevillea (type species, F. planorbis, n. sp.), Pygmaeoceras (type species, Gastrioceras pygmaeum Mather, 1915), and Axinolobus (type species, A. modulus, n. sp.) which are ammonoids. The following new names are also proposed: Rayonnoceras foersti, n. name for R. vaughanianum, Foerste and Teichert, 1930 [not R. vaughanianum Girty, 1909=R. girtyi Foerste and Teichert, 1930]; Peripetoceras whitei, n. name for Nautilus missouriensis? White, 1884 [not N. missouriensis Swallow, 1858]; Coelogasteroceras coxi, n. name for Nautilus canaliculatus Cox, Apr. 1858 [not N. canaliculatus Eichwald, Oct. 1857]; and Neoglyphioceras hyatti, n. name for Gastrioceras entogonum (Gabb)? Hyatt, 1891 [not Goniatites entogonus Gabb, 1862]. Lectotypes are selected for Cravenoceras incisum (Hyatt) [=Glyphioceras incisum Hyatt, 1893], for Paracravenoceras barnettense (Plummer and Scott) [=Nuculoceras barnettense Plummer and Scott, 1937 =Goniatites choctawensis barnettensis Miller and Youngquist, 1948], and for Pygmaeoceras pygmaeum (Mather) [=Gastrioceras pygmaeum Mather, 1915].--Auth.

2-609. Howarth, M. K. GENERIC NAMES FOR AMMONOIDEA PUBLISHED DURING THE PERIOD 1758-1954: Jour. Paleontology, v. 34, no. 1, p. 194-200, Jan. 1960.

Generic names for Ammonoidea during the period 1758-1954 but not included in Volume L of the

Treatise on Invertebrate Paleontology are listed and, in most cases, interpreted along similar lines to those used in the treatise. The list comprises 72 available names and 39 that have been suppressed.--Auth.

2-610. Seilacher, Adolf. EPIZOANS AS A KEY TO AMMONOID ECOLOGY: Jour. Paleontology, v. 34, no. 1, p. 189-193, 3 illus., Jan. 1960, 12 refs.

The way in which epizoic oysters are attached to an adult shell of Buchiceras indicates that, 1) this shell was not covered by soft parts, 2) the adult stage of an ammonoid lasted probably for years, 3) Buchiceras did not crawl on the sea floor but swam in a position similar to that of living Nautilus.--Auth.

2-611. Whittington, Harry B. SILICIFIED MIDDLE ORDOVICIAN TRILOBITES: REMOPLEURIDIDAE, TRINUCLEIDAE, RAPHIOPHORIDAE, ENDYMIONIDAE: Harvard Univ., Mus. Comp. Zoology, Bull., v. 121, no. 8, p. 371-496, 36 pls., 8 figs. incl. illus., sec., diags., Nov. 1959, 45 refs.

A portion of remarkable silicified material from Virginia is described. Lists give the stratigraphic distribution of all the trilobites from the Middle Ordovician of Virginia so far studied. From these lists support is derived for the correlation and classification of Middle Ordovician rocks recently proposed by G. Arthur Cooper. The species of Raymondella and Salteria described here are the only ones known other than the type species from Scotland, a striking example of the close similarities between some 12 species in the lower Edinburg formation and species of the same age in northwestern Europe. The rocks in each region also contain species of genera not known in the other.

Of the families here dealt with, this is the best preserved material so far known of both mature and developmental stages of the exoskeleton. The protaspis of a remopleuridid from older rocks had previously been described by Ross. The protaspides of 5 different species of Remopleurides are described here, and show a likeness to each other and to the older one. The species of Remopleurides occur through some 500-900 ft. of limestone in Virginia, about 75 ft. separating the upper Lincolnshire and earliest lower Edinburg occurrences, and perhaps 350 ft. separating the latest lower Edinburg and lower Martinsburg trilobite-bearing layers. A continuous record of an evolving series of forms is thus not available, but rather the collections reveal the appearance of new species at different levels and their disappearance at various times. There are 2 pairs of distinct but closely similar species, one pair comprising R. asperulus and R. eximius in the upper Lincolnshire and lower Edinburg, the other including R. caelatus and R. plaesiourus in the lower Edinburg and lower Martinsburg respectively. The pairs are quite dissimilar, and unlike either of the 2 additional species in the lower Edinburg. Morphological characters common to Remopleurides are differently developed in these and in other species - the great morphological detail revealed by the present material suggests the broad limits to the genus here drawn, but blurs distinctions which the author might earlier have made between groups of species. The species of Robergia is like other species in this country and northwestern Europe; a few developmental stages are described. Robergiella n. gen. is based on fragmentary material, and displays characters intermediate between Remopleurides and Robergia.

Meraspid developmental stages of trinucleids have been described by several authors, but the present material includes the protaspis of 2 genera. The new species of Tretaspis is closely related to species of the same age from New York and Quebec, and to a younger species from Norway. The development of a raphiophorid was hitherto unknown. The development of 4 species, each belonging to a different genus, is here described and in one the series begins with the protaspis. The latter, and early meraspides, are like those of trinucleids, and display alae. A close relationship between these 2 families is thus suggested.--From auth. introd.

2-612. Leutze, Willard P. SILURIAN FISH FOSSILS IN THE SALINA BASIN: Geol. Soc. America, Bull., v. 71, no. 2, p. 215-217, map, Feb. 1960, 5 refs.

New Silurian cyathaspid fish localities have been found in the Wills Creek formation of West Virginia and Maryland. Late Silurian fishes had been reported previously from the same states, Pennsylvania, New Jersey, and New York. In the Salina basin, occurrences are restricted to the eastern margin, chiefly in or near the red clastic facies. Eurypterids of the same basin have a different distribution pattern and are found principally in argillaceous carbonates. --Auth.

2-613. Selton, Richard J. A REVIEW OF THE FAMILY CAPTORHINIDAE: Chicago, Nat. History Mus., Fieldiana: Geology, v. 10. no. 34, p. 461-509, illus., diags., Oct. 1959, 51 refs.

The family Captorhinidae contains all of the captorhinomorph reptiles found in early Permian deposits of Clear Fork and later age and a few specimens of one species from the Wichita. The family includes the following genera, with their known geologic ranges: Captorhinus, Admiral to late Vale; Labidosaurus, early Clyde to late Arroyo; Captorhinoides, early Vale only; Rothia, San Angelo and Flower Pot; Labidosaurikos and Captorhinikos, both early Vale to early Choza. Captorhinus and Labidosaurus are closely related, the only real difference being in the dentition, the former having multiple rows of teeth and the latter but a single row. Captorhinikos and Labidosaurikos are also closely related, both being clearly derivatives of the Captorhinus line; they differ in the basic makeup of the multiple tooth rows and in the shape of the skull. Captorhinoides and Rothia are not closely related, but both apparently originated through unknown intermediate forms from Captorhinus aguti.--M. Russell.

2-614. Olsen, Stanley John. AGE AND FAUNAL RELATIONSHIP OF TAPIRAVUS REMAINS FROM FLORIDA: Jour. Paleontology, v. 34, no. 1, p. 164-167, illus., table, Jan. 1960, 12 refs.

Tapiravus remains are known from 3 widely separated localities in the eastern United States. Sufficient material from the Bone Valley deposits of peninsular Florida, is now known to warrant establishing this genus of tapirs as occurring in Florida during the upper Miocene or lower Pliocene times and in recording the type description of Tapiravus polkensis. --Auth.

2-615. Russell, Robert J. PLEISTOCENE POCKET GOPHERS FROM SAN JOSECITO CAVE, NUEVO LEON, MEXICO: Kansas, Univ., Mus. Nat. History, Pubs., v. 9, no. 21, p. 541-548, 2 illus., table, Jan. 14, 1960, 9 refs.

Four fossil geomyids from San Josecito Cave near Aramberri are described. Of them Heterogeomys onerosus is a new species. The presence of the genus itself suggests a tropical situation when the gophers were taken by predators and carried into the cave.--M. Russell.

2-616. Hall, E. Raymond. SMALL CARNIVORES FROM SAN JOSECITO CAVE (PLEISTOCENE), NUEVO LEON, MEXICO: Kansas, Univ., Mus. Nat. History, Pubs., v. 9, no. 20, p. 533-538, illus., Jan. 14, 1960, 8 refs.

Six fossil Carnivora from San Josecito Cave near Aramberri, are described. Of them, Mustela reliquus is a new species. Of the 6, 2 are specifically different from, and 4 are indistinguishable from, their Recent relatives. This ratio of "extinct" to living kinds suggests that the fauna is late Pleistocene in age and therefore approximately the same as the fauna of Papago Spring Cave, Arizona, but older than the fauna of the Rancho La Brea tar pits of California.--M. Russell.

2-617. McLaren, I. A. ON THE ORIGIN OF THE CASPIAN AND BAIKAL SEALS AND THE PALEOCLIMATOLOGICAL IMPLICATIONS: Am. Jour. Sci., v. 258, no. 1, p. 47-65, 5 figs. incl. illus., maps, graph, Jan. 1960, 41 refs.

The Caspian and Baikal seals, closely related to the ringed seal of the Arctic seas, are usually held to have arrived as a result of Pleistocene events. However, evidence suggests that they are relicts of late Miocene connections with the Arctic basin. The 3 species are more differentiated than is generally supposed. More important, some of the fossils from the upper Miocene of southern Russia and Hungary (and perhaps elsewhere) belong to the same subgenus (Pusa), and remains of the present Caspian seal are found in lower Pleistocene deposits, formed before the putative glacial entry of seals.

The fossils most readily diagnosed as belonging to the ringed seal group are an anterior fragment of a skull attributed to Phoca pontica by Alekseev and part of a lower jaw named Praepusa pannonica by Kretzoi. Some of the syntypes of Phoca pontica Eichwald (1853) also belong to this group, and a lectotype is accordingly chosen here to prevent further confusion of the name. Much confusion has resulted from the identification by Simionescu as Phoca pontica of a form with a peculiar, distally expanded femur; this species is named Pontophoca sarmatica (Alekseev) n. comb. The synonymies of other forms which have been involved with the status of Phoca pontica are reviewed, and lectotypes chosen when necessary.

The northern seals (subfamily Phocinae) are relatively cold stenothermic and probably entered the Sarmatian basin by direct connections to the N. The pups of living Phocinae have white coats as an adaptation to birth on ice, and this is almost certainly of common ancestry; the 3 species of the subgenus Pusa, within this subfamily, even more probably retain this adaptation from a common ancestor. Thus, if the ancestors of the Caspian seal were present in late Miocene times, ice almost certainly formed then at least in the Arctic basin, and probably in the innermost reaches of the Sarmatian sea.--Auth.

2-618. Cifelli, Richard. BATHONIAN FORAMINIFERA OF ENGLAND: Harvard Univ., Mus. Comp. Zoology, Bull., v. 121, no. 7, p. 265-368, 7 pls., 4 figs. incl. illus., chart, sec., 18 tables, Sept. 1959, 103 refs.

In this paper 104 Jurassic species, subspecies, and varieties (exclusive of attached forms) are described and their known stratigraphic occurrences are recorded. These include one species (Massilina dorsetensis) and one subspecies (Vaginulina clathrata eypensa) which are new. Four foraminiferal faunules can be distinguished, which should provide a framework for future faunal divisions of this stage. The faunules are provisional units and cannot be used to establish zones at present because their stratal limits are not known and their relationships to larger Middle Jurassic faunal limits within the European province are not yet known. However the faunules can be recognized in Dorset and the Bath areas where they occur in the same order of superposition. Consequently, they contain stratigraphically restricted species which should later prove useful in establishing zones based on Foraminifera.

The Bathonian fauna is characterized by the dominance of the Lagenidae. Representatives of this family occur in a large variety of sediments, and in practically all instances they are the most common forms in the assemblages. Other families are represented by few, unspecialized genera and species.

Classification of specimens of Jurassic Lagenidae is difficult because species and genera do not have well-defined morphological limits. Nevertheless, because it is believed that recognition of variation is vital to an understanding of the evolution of the family, many lagenid species are here conceived quite broadly.--From auth. introd.

2-619. Beddoes, Leslie R., Jr. FORAMINIFERAL POPULATIONS OF THE GOODLAND FORMATION, TARRANT COUNTY, TEXAS: Field & Lab., v. 27, no. 2, p. 51-70, 5 figs. incl. 2 maps, sec., fold. chart, Apr. 1959, 23 refs.

In western Tarrant County, Texas, the Goodland formation (Lower Cretaceous) is 121 ft. thick. The formation consists of 2 parts, a lower marl member and upper limestone member. Foraminiferal tests are common throughout the Goodland, and are especially abundant in the marl beds, where they occur in numbers ranging upward to 5,000 per cu. cm.

Fifty-two samples, collected from as many different horizons, were analyzed according to their content of foraminiferal tests, classified by genus and species. Agglutinated tests, mostly of the Lituolidae, are generally abundant throughout the formation, but show an increase in number of individuals and species upward in the section. Coskinolinoides appears in great numbers at the very top. Conversely, the Rotaliidae, which are the predominant family among the calcareous benthonic tests, decrease in relative numbers upward. Planktonic tests are rare throughout the formation.

The results of this analysis, together with independent evidence provided by megafossils and primary structures, suggest that the older Goodland sediments were deposited in warm, shallow, muddy, subsaline water. In late Goodland time the water cleared, and perhaps the upper layers became more saline. In general these ancient sediments are of the same kind as found in modern bays and sounds,

or along the inner margins of the continental shelves. --Auth.

2-620. Olsson, Richard K. FORAMINIFERA OF LATEST CRETACEOUS AND EARLIEST TERTIARY AGE IN THE NEW JERSEY COASTAL PLAIN: Jour. Paleontology, v. 34, no. 1, p. 1-58, 12 pls., map, chart, Jan. 1960, 125 refs.

The Redbank, New Egypt, and Hornerstown formations have yielded a total of 184 species of Foraminifera, 44 of which are new. Benthonic and planktonic Foraminifera from the Redbank sand and the lower part of the New Egypt sand suggest a post-Navarroan - pre-Tertiary age. The occurrence of Tertiary species, especially species of Globorotalia, in these faunas emphasizes the very late Cretaceous age. The Hornerstown greensand and the upper part of the subsurface New Egypt sand contain several planktonic faunas. These represent the early Paleocene Globorotalia compressa-Globigerinoides daubjergensis zone, the late Paleocene Globorotalia pseudobulloides subzone of the Globorotalia angulata zone, and the oldest part of the subzone of Globorotalia velascoensis-Globorotalia acuta-Globigerina spiralis. The latter is believed to be early Eocene in age. A benthonic fauna from the upper part of the Hornerstown greensand is inconclusive as to either Paleocene or Eocene age.--Auth

2-621. Benson, Richard H. ECOLOGY OF RECENT OSTRACODES OF THE TODOS SANTOS BAY REGION, BAJA CALIFORNIA, MEXICO: Kansas, Univ., Paleont. Contr. [no. 23] (Arthropoda, art. 1), p. 1-80, 11 illus., 11 maps, chart, 8 profiles, diag., July 1959, 213 refs.

Recent ostracodes (46 species, 31 genera) belonging to 6 principal biofacies were collected from an estuary, salt-water lagoon, and large open bay on the W. coast of Baja California, 60 mi. S. of San Diego, California. These include a brackish-water biofacies, a salt-water lagoon and salt-marsh biofacies, and an open-bay megabiofacies with 4 biofacies and a subfacies which are dependent on depth, vegetation, and substratum.

Living and dead ostracodes were collected and studied from 316 samples of the top 1 cm. of sediment at 170 stations. Depth ranges from supratidal to 215 fathoms in Todos Santos Bay, salinity from 0.5 parts per thousand (o/oo) in the Rio San Miguel estuary to 37 o/oo in the salt-water lagoon of the Estero de Punta Banda, and temperature from 50°F. in the deeper parts of the bay to 85°F. in the salt-water lagoon (estero). The substratum consists of rock, cobbles, coarse to fine sand to poorly sorted, very fine silt and clay, with the finer sediments predominant. The vegetation primarily comprises eel grass, coralline algae, Laminaria, and Macrocystis.

Among the ostracodes 28 species belonging to 19 genera show sufficient ecologic restriction and stratigraphic range to be used as biofacies indicators in ancient sediments, several of the species ranging back into the Pliocene. Salinity and depth of water are the 2 factors that seem most to affect the distribution of ostracodes in the areas studied. The distribution of structural types of plants greatly influences the distribution of the ostracodes that live closely associated with them. Many forms reflect in their carapace morphology their life mode as living on or among plants (phytal), in or on sand bottom (endopsammon, epipsammon), and in or on mud bottom (endopelos, epipelos). The distribution of certain sediment types of the substratum can be correlated with the abundance as well as the character of some biofacies.--Auth.

2-622. Winslow, Marcia R. UPPER MISSISSIPPIAN AND PENNSYLVANIAN MEGASPORES AND OTHER PLANT MICROFOSSILS FROM ILLINOIS: Illinois State Geol. Survey, Bull. 86, 135 p., 16 pls., map, 3 charts, 4 diags., 2 graphs, 3 tables, 1959, 127 refs.

A preliminary investigation of land plant megaspores and other resistant plant parts from the plus 65-mesh maceration residues of coals and carbonaceous layers of upper Mississippian (Chester series) and Pennsylvanian age indicates that plant megaspores are useful in correlation, especially on a local scale, and may in the future aid in delineating coal swamp heterosporous plant distribution.

The study established that megaspore assemblages of Chester age are dominated by spinose lageniculate and fibrous-coated megaspores representing an arborescent lepidodendrid-lepidocarp flora. Megaspores of the Caseyville group indicate a more diverse heterosporous flora, including both herbaceous and arborescent lycopsids. Spinose lageniculate, fibrous-coated, auriculate, zonate, and deltoid-bladdered spores dominate the assemblages. The oldest occurrences of sigillarians and medullosans are represented by spinose aphanozonate and monolete spores, respectively. Sphenopsids are also represented.

From the base of the Tradewater group, to and including the Pope Creek coal, the assemblages are distinguished by their great diversity of zonate megaspores, by abundant triangulate megaspores, and by the occurrence, apparently restricted, of one new genus. The upper part of the Tradewater group is characterized by smooth lageniculate spores, abundant monolete medullosan spores, and by the lowest occurrence of spores with lateral bladders.

The assemblages from the Summum (no. 4) coal to the top of the Carbondale group are characterized by an abundance of smooth aphanozonate spores of sigillarian alliance, but, except for the absence of zonate spores, are otherwise similar to those of the Tradewater group. The assemblages of the McLeansboro group, not investigated extensively, appear to be characterized by heavy-apexed, smooth lageniculate-type spores, smooth aphanozonate spores, auriculate spores, monolete medullosan spores, both deltoid- and lateral-bladdered spores, and by the absence or extreme rarity of the fibrous-coated spores and zonate spores.

Zonation of megaspores from upper Mississippian and Pennsylvanian coals is possible, based on the differentiation of lageniculate spores, restricted ranges of some spores, and, in some instances, marked variation in abundance.--Auth.

2-623. Jones, David L. LOWER CRETACEOUS (ALBIAN) FOSSILS FROM SOUTHWESTERN OREGON AND THEIR PALEOGEOGRAPHIC SIGNIFICANCE: Jour. Paleontology, v. 34, no. 1, p. 152-160, pl., 2 maps, Jan. 1960, 23 refs.

Lower Cretaceous marine strata exposed near Mitchell, central Oregon, were previously the only known deposits of Albian age in Oregon. Recognition of another exposure of Albian strata on Grave Creek, southwestern Oregon, permits speculation on the paleogeography of Oregon during Albian time. It is suggested that the Albian sea in central Oregon had

a connection with the open ocean to the W. and transgressed southerly and southeasterly. The Grave Creek fauna consists, in part, of: Oxytropidoceras? sp. indet., Lyelliceras n. sp.?, Cleoniceras? dilleri Jones, n. sp., Inoceramus (Actinoceramus) concentricus Parkinson, I. (A.) "subsulcatus" Wiltshire, I.(A.) salomoni d'Orbigny, and Megatrigonia (Apiotrigonia) condoni (Packard). --Auth.

6. GEOPHYSICS

See also: Structural Geology 2-566; Mineral Deposits 2-726; Engineering Geology 2-761.

2-624. Chapman, Sydney. THE INTERNATIONAL GEOPHYSICAL YEAR: Alaska, Univ., Geophys. Inst., Contr. Ser. A, no. 44, [11] p., [1959]; reprinted from: ICSU Review, v. 1, no. 1, Jan. 1959.

The achievements of the International Geophysical Year and the organization which carried it out are summarized. Weather observations formed the largest single section of the program. Expeditions to the Antarctic made substantial contributions to Antarctic geography. Rockets explored the upper atmosphere for measurements of pressure, temperature, density, composition, and electron and ion content. The Pacific Ocean river, 3,500 mi. long, 250 mi. wide, and flowing eastward at 25 m.p.h., was discovered. The central organizing body was the Special Committee of the International Council of Scientific Unions (ICSU). Sixty-seven countries had committees participating in the IGY.--M. Russell.

2-625. White, J. E., and Frank Press. GEOPHYSICAL RESEARCH AND PROGRESS IN EXPLORATION: Geophysics, v. 25, no. 1, p. 168-180, Feb. 1960.

This is the fourth in a series of review papers [the first 3 presented in 1955, 1956, and 1957] dealing with technological developments in exploration and with geophysical research at universities and industrial laboratories.

Among the developments in exploration, the use of reproducible recording of seismic records continues to grow, with a trend toward digitizing reflection data for further computation. Refined digital methods have been developed for computation of synthetic seismograms. Well-logging developments have included the appearance of a resistivity logger capable of being pumped down the drill pipe; the availability of more tools for logging seismic velocity, accompanied by laboratory investigations of the manner in which seismic velocity is affected by porosity, fluid content, and other factors; commercial use of the scattered-gamma ray density tool; and further interest in gamma ray spectral logs. Remarkable advances have been made in the techniques of gravity measurement aboard surface vessels and aircraft, although the results are not directly applicable to prospecting. The proton precession magnetometer is being used in commercial air-borne surveys, but the Rb vapor magnetometer is not available as an exploration tool. The development of a Doppler-positioned navigation method has greatly facilitated air-borne surveys. A ship-borne seep-detector has been outfitted for exploration in water-covered areas.

A review is presented of research on all phases of geophysics at academic institutions in the United States, including laboratory experiments, field measurements, and theory. The review also gives partial coverage of geophysical research at European laboratories, including a discussion of Soviet research as gauged by recent visits to a number of research laboratories in the Soviet Union.--Auth.

2-626. Born, William T. A REVIEW OF GEOPHYSICAL INSTRUMENTATION: Geophysics, v. 25, no. 1, p. 77-91, Feb. 1960, 49 refs.

This paper is a historical review of the development of instrumentation used in all phases of geophysical prospecting, including well logging. Particular reference is made to pertinent papers published in Geophysics and its predecessor publications.--Auth.

2-627. Orlin, H. THE THREE COMPONENTS OF THE EXTERNAL ANOMALOUS GRAVITY FIELD: Jour. Geophys. Research, v. 64, no. 12, p. 2393-2399, chart, 6 diags., 2 tables, Dec. 1959, 9 refs.

By means of a surface coating determined from the gravity anomalies at sea level and from the geoid heights, the 3 components of the external anomalous gravity field are computed. This technique is applied to points at and above sea level and comparisons are made with existing methods.--Auth.

2-628. O'Keefe, John A. DETERMINATION OF THE EARTH'S GRAVITATIONAL FIELD: Science, v. 131, no. 3400, p. 607-608, Feb. 26, 1960, 4 refs.

Brenner et al. have pointed out that spurious variations may be introduced into computation of satellite orbits by a combination of the use of osculating elements and a maldistribution of the observations. They suggest that this circumstance is the source of the eccentricity variations in the Vanguard I orbit which have been attributed to the third zonal harmonic. This criticism is based on a misunderstanding of the Vanguard orbit and tracking programs. The source materials for our study of the third zonal harmonic were not osculating elements, and the observations were in fact uniformly distributed around the Vanguard I orbit.--Auth.

2-629. O'Keefe, John A. ZONAL HARMONICS OF THE EARTH'S GRAVITATIONAL FIELD AND THE BASIC HYPOTHESIS OF GEODESY: Jour. Geophys. Research, v. 64, no. 12, p. 2389-2392, 3 graphs, table, Dec. 1959, 10 refs.

The basic hypothesis of geodesy as stated by Vening Meinesz and Heiskanen calls for an extremely smooth gravitational field for the earth as a whole, apart from local irregularities. From satellite measurements of zonal harmonics of orders 2, 3, and 4 it is shown that the actual roughness is about an order of magnitude greater than that demanded by the basic hypothesis of geodesy.--Auth.

2-630. Haubrich, Richard A., Jr., and Walter H. Munk. THE POLE TIDE: Jour. Geophys. Research, v. 64, no. 12, p. 2373-2388, 4 graphs, 5 tables, Dec. 1959, 24 refs.

About 10,000 mean monthly values of sea level from 11 tide stations have been analyzed by the method of Tukey to obtain the power spectra in the frequency range of 0.0125 to 6 cycles per year (c.p.y.). The

spectral density is on the order of 10^3 mm.^{2}/c.p.y. and is remarkably uniform over this frequency range, with the following exceptions; 1) a sharp rise at the low-frequency tail, from 10^3 mm.^{2}/c.p.y. at 0.1 c.p.y. to 10^5 mm.^{2}/c.p.y. at 0.0125 c.p.y. (presumably associated with variations in recorded sea level arising from continental unrest); 2) the line spectrum associated with the annual variation and its harmonics; and 3) a weak peak of 0.84 c.p.y., barely above noise level, which is identified with the 14-month 'pole tide' corresponding to the earth's free nutation (Chandler wobble). The average pole tide for all stations gives an amplitude twice that predicted by equilibrium theory. The contribution to the peak of the pole tide is largely from 3 localities: Swinemünde, Marseille, and a combined set of Netherlands stations. Apparently the pole tide is not in accord with equilibrium theory. This raises some questions concerning the interpretation of Love numbers as derived from the period of free nutation.--Auth.

2-631. Kaula, William M. STATISTICAL AND HARMONIC ANALYSIS OF GRAVITY: Jour. Geophys. Research, v. 64, no. 12, p. 2401-2421, 2 maps, 2 diags., 2 graphs, 11 tables, Dec. 1959, 21 refs.

Markov theory is developed in terms of 2 correlated functions, the free-air gravity anomaly and the elevation of the topography. The Markov methods are applied to the mean anomalies of $1^\circ \times 1^\circ$ blocks to extrapolate from all available observations to obtain estimates of mean anomalies of $10^\circ \times 10^\circ$ blocks world-wide. These estimates are adjusted so that the even-degree zonal harmonics are consistent with the precession of the node of satellite 1958β and so that the inadmissible first- and second-degree harmonics are absent. Spherical harmonic coefficients up to the eighth degree ($P_{s,s}$ terms) for free-air gravity are computed.

An independent autocorrelation analysis is made in order to estimate the variance of mean anomalies of blocks and the variance of each degree of the spherical harmonics. This analysis is utilized as a control on the error variances and covariances of the mean anomaly estimates made by the Markov method.

The results are used in conjunction with the zonal harmonics derived from satellite motions to obtain a best estimate of the exterior potential in spherical harmonics from terrestrial gravimetry up to June 1958 and satellite data up to Dec. 1958. It is planned to revise this estimate periodically as new observational data become available.--Auth.

2-632. Talwani, Manik, and Maurice Ewing. RAPID COMPUTATION OF GRAVITATIONAL ATTRACTION OF THREE-DIMENSIONAL BODIES OF ARBITRARY SHAPE: Geophysics, v. 25, no. 1, p. 203-225, chart, 4 diags., graph, 2 tables, Feb. 1960, 17 refs.

An expression is derived for the gravity anomaly at an external point caused by a horizontal lamina with the boundary of an irregular polygon. This expression is put in a form suitable for computation by a high speed digital computer. By making the number of sides of the polygon sufficiently large, any irregular outline can be closely approximated. Any 3-dimensional body can be represented by contours. By replacing each contour by a polygonal lamina, the anomaly caused by it can be obtained at any external point. By a system of interpolation between contours combined with a numerical integration the gravity anomaly caused by the 3-dimensional body can be calculated to a high degree of precision.

This method may also be used for rapidly computing terrain corrections on a flat earth. By making a small modification it can further be adopted for computing the terrain correction as well as local isostatic compensation on the Airy system up to the external radius of Hayford zone O on a spherical earth.

The expression for the anomaly caused by a horizontal polygonal lamina is also obtained for the special case when the sides of the polygon are alternately parallel to the x- and y- axes, that is, the polygonal lamina can be divided into a number of rectangular laminae. A chart is provided for the hand computation of the gravity anomaly in this case.--Auth.

2-633. Thompson, Lloyd G.D., and Lucien J.B. LaCoste. AERIAL GRAVITY MEASUREMENTS: Jour. Geophys. Research, v. 65, no. 1, p. 305-322, illus., map, 2 profiles, 5 graphs, Jan. 1960, 4 refs.

Tests with an airborne LaCoste and Romberg sea gravity meter (surface type) have shown that gravity measurements in a flying aircraft are feasible. At high altitudes the aircraft was a sufficiently stable platform for the gravity meter to operate satisfactorily. Analysis of in-flight acceleration problems has shown that gravity observations can be made at high aircraft velocities with proper flight programing and navigation systems. N., S., and W. traverses over an Askania tracking range gave 5 min. average gravity readings which plotted into smooth profiles. An accuracy of better than 10 mgal. was obtained which meets requirements for geodetic applications where mean gravity values for $1^\circ \times 1^\circ$ squares are required.--Auth.

2-634. Nettleton, Lewis L., Lucien J.B. LaCoste, and J.C. Harrison. TESTS OF AN AIRBORNE GRAVITY METER: Geophysics, v. 25, no. 1, p. 181-202, 10 figs. incl. 2 maps, 2 profiles, diag., 2 tables, Feb. 1960, 11 refs.

Gravity measurements have been made in an airplane and a contour map using 20-mg. interval constructed for 12,000-ft. elevation. The LaCoste and Romberg instrument used is similar to that recently tested on a surface ship. The meter was installed in a B-17 aircraft equipped with APR (precision radar altimeter) and aerial mapping cameras for the accurate navigation needed for determination of the centrifugal (Eötvös) and elevation corrections. A series of 9 lines over the Imperial Valley gave results believed to be accurate to about 10 mg. or better as indicated by 1) the general consistency of the contour map and its similarity to a free air gravity map drawn from ground data, 2) repeat observations over almost the same courses, 3) agreement of independent values at line crossings (with Eötvös correction differences of as much as 2,000 mg.), and 4) agreement with values calculated from ground gravity stations. Short period disturbances due to accelerations of the airplane are averaged over a certain time interval. This results in an "uncertainty principle," in that the accuracy of observation increases as this time interval is lengthened, but details of the gravity variation are lost due to the increased distance traveled during each measurement. The values reported are for an averaging time of approximately 3 minutes corresponding to a travel distance of about 10 mi. The

quality of the results is adequate for geodetic purposes and possibly for certain regional geophysical problems.--Auth.

2-635. Verhoogen, John. THE ORIGIN OF THERMOREMANENT MAGNETIZATION: Jour. Geophys. Research, v. 64, no. 12, p. 2441-2449, table, Dec. 1959, 12 refs.

Thermoremanent magnetization (trm) generally has several components characterized by a range of coercive force. The component of trm which has the highest stability with respect to ac-demagnetization is believed to reside in stressed regions surrounding dislocations. Because of their size and shape, these regions behave much as single-domain particles.--Auth.

2-636. Sato, Motoaki, and Harold M. Mooney. THE ELECTROCHEMICAL MECHANISM OF SULFIDE SELF-POTENTIALS: Geophysics, v. 25, no. 1, p. 226-249, 7 diags., Feb. 1960, 37 refs.

Self-potentials associated with a sulfide ore body result from the ohmic potential drop within the country rocks. The electric current is produced by separate but simultaneous reduction of oxidizing agents near the surface and oxidation of reducing agents at depth. The ore does not participate directly in either reaction, but serves as a conductor to transfer the electrons from the reducing agents to the oxidizing agents. The possibility for the above reactions to occur depends upon differences in oxidation potential of ground waters at different depths. In the zone of weathering, the oxidation potential is controlled by the reduction mechanism of O, and ranges in value from 0.2 to 0.7 volt (on the H scale). If the ore tends to oxidize at some lower potential, then the latter is the available one. In the zone beneath the water table, the potential is probably controlled by the oxidation-reduction equilibria of Fe-rich minerals, and ranges in value from 0 to -0.3 volt. The available potential is independent of ore type. The maximum potential difference available to produce natural currents is estimated at: graphite 0.8, pyrite 0.7, covellite 0.6, chalcocite 0.5, galena 0.3 volt. Self-potentials will be large if the ore body 1) is composed of minerals difficult to oxidize, 2) has low electrical resistance (physical continuity together with low resistivity), 3) extends vertically across the water table, and 4) exists close to the surface.--Auth.

2-637. Frischknecht, Frank C. SCANDINAVIAN ELECTROMAGNETIC PROSPECTING: Mining Engineering, v. 11, no. 9, p. 932-937, 3 diags., Sept. 1959, 8 refs.

Electromagnetic prospecting used in Scandinavia includes methods in which the position of the energizing system remains fixed and methods in which both the source and receiver are moved about over the area being investigated. For these methods, respectively, long grounded cables or large horizontal insulated loops and small portable loops are used. Various modifications of the basic surface methods are used for mobile operation on both ground and in the air. Comparisons are made between the systems, and recent developments in equipment design are described.--Auth.

2-638. Crawford, John M., William E.N. Doty, and Milford R. Lee. CONTINUOUS SIGNAL SEISMOGRAPH: Geophysics, v. 25, no. 1, p. 95-105, 4 illus., 5 diags,, Feb. 1960, 3 refs.

The paper describes a seismic method in which a continuous signal vibrator provides the source energy. Operational features as well as some general theoretical considerations are discussed.--Auth.

2-639. Lindsey, J.P. ELIMINATION OF SEISMIC GHOST REFLECTIONS BY MEANS OF A LINEAR FILTER: Geophysics, v. 25, no. 1, p. 130-140, 8 figs., Feb. 1960, 3 refs.

A technique is described for elimination of ghost reflections on magnetically recorded seismograph records by means of a linear filter. The application of this filter does not alter the character of primary reflections although eliminating the ghost reflections. The principal assumption made in the development of the technique is that the effect of AGC in altering the amplitude ratio of primary and ghost reflections is uniform for all record time.

A realization of the required filter is given and a measurement technique is outlined for detecting the existence of ghost reflections based on the autocorrelation function of the seismograph trace.--Auth.

2-640. Graebner, R.J. SEISMIC DATA ENHANCEMENT - A CASE HISTORY: Geophysics, v. 25, no. 1, p. 283-311, 17 figs. incl. 6 diags., graph, Feb. 1960, 11 refs.

The theory relating to many methods - for example, multiple seismometer techniques - which the geophysicist may control to improve record quality is well known. However, its application has not been fully exploited. An example of the reduction of theory to practice in one area characterized by poor records is presented. It comprises a series of analytical tests designed to discover the cause of poor records, to examine the effect of each variable on the signal-to-noise ratio, and to evaluate the solutions predicted by theory. The tests showed that the poor record quality was attributable chiefly to relatively strong surface and near-surface waves propagating outward from the shot. Wave length filtering by means of suitable shot and seismometer patterns, and compositing through data processing methods, greatly improved record quality and permitted magnetic recording of reflected signals over a broad frequency range. The tests established, in the allotted time, that the quality of the data would meet clearly specified standards of performance.

Experience has shown that better seismic data can generally be obtained when the design of techniques is based on the special character of the signal and noise determined from simple tests rather than when the design is based on general assumptions. --Auth.

2-641. Wuenschel, Paul C. SEISMOGRAM SYNTHESIS INCLUDING MULTIPLES AND TRANSMISSION COEFFICIENTS: Geophysics, v. 25, no. 1, p. 106-129, 11 figs. incl. diags., seismograms, Feb. 1960, 7 refs.

Synthetic seismograms that include multiples and transmission coefficients have been obtained by solving the boundary value problem for the multilayered half-space exactly for the plane wave case at normal incidence. The computations of 4 seismograms of interest have been programmed for the IBM 704. The seismograms differ in location of source and detector, i.e., whether buried or at the

surface of the half-space and whether or not this surface is a stress-free surface. Evaluation of the computer programs prior to synthesizing seismograms is accomplished by comparing computer with analytical solutions of simple problems.

The significance of multiples to the total reflected signal depends on the vertical distribution of acoustic impedance. For small contrasts in acoustic impedance distributed throughout the section, multiples are relatively insignificant. For moderate contrasts similarly distributed, multiples can produce discrete events, cause phase shifts in large amplitude direct reflections, and alter the frequency of weak direct reflected signal. If the near-surface contrasts are large, then multiples within these layers can mask a direct reflected signal from depth by producing "ringing" or "wave training." The present analysis gives a more reasonable explanation of "ringing" records than has been given heretofore. It is evident when comparing synthetic seismograms, including multiples with field seismograms, that the predicted multiple contribution in many cases is greater than actually present, indicating that the mathematical model on which computation is based is not yet adequately realistic.--Auth.

2-642. Aki, Keiiti. THE USE OF LOVE WAVES FOR THE STUDY OF EARTHQUAKE MECHANISM: Jour. Geophys. Research, v. 65, no. 1, p. 323-331, 2 maps, 5 diags., 2 tables, Jan. 1960, 16 refs.

Long-period Love waves of continental path were successfully used for the study of the mechanism of earthquakes. Wave forms were compared for earthquakes of similar size which occurred within a limited area and were recorded by the same instrument at a given station. The aftershocks of the Kern County [California] earthquake of 1952 and the series of Nevada shocks during 1954 were studied, and the direction of lateral fault motion derived from Love waves was found to agree perfectly with that derived from the data on body waves. We also found a very definite fact which cannot be explained by postulating a single couple for an earthquake source and which strongly supports Honda's hypothesis of a pair of couples. This additional information from the Love wave data confirmed the belief that the fault plane solutions have great geotectonic significance, at least for the area studied.--Auth.

2-643. Sengbush, R. L. COMMENTS ON "FREQUENCY ANALYSIS OF SEISMIC PULSES," SECTION I (THEORY): Geophysics, v. 25, no. 1, p. 322-324, Feb. 1960.

Referring to the paper on photomechanical frequency analysis of seismic pulses by Howell, Andrews, and Huber (GeoScience Abstracts 1-3037), Sengbush objects to the statement "a transient pulse does not have the property of frequency," and shows that discrete spectra cannot possibly describe the transient and that it is necessary to consider amplitude density rather than amplitude in the transient case. If sampling of the time waveform is done properly, the resulting Fourier spectra will characterize the sampled waveform which in turn specifies the continuous waveform.

In reply, Howell states that the real pulse has the property of frequency only in the analytical sense, as it is not in general a sum of parts. The photomechanical method has inherent inaccuracies, but for the same amount of time and effort as in the Fourier method, which is also an approximation, it gives more terms of the Fourier analysis with equal or greater accuracy.--D. B. Vitaliano (courtesy Geophysical Abstracts).

2-644. Brune, James N., John E. Nafe, and Jack E. Oliver. A SIMPLIFIED METHOD FOR THE ANALYSIS AND SYNTHESIS OF DISPERSED WAVE TRAINS: Jour. Geophys, Research, v. 65, no. 1, p. 287-304, 18 figs. incl. diags., graphs, seismograms, 2 tables, Jan. 1960, 20 refs.

A disturbance at one point of a dispersive medium resulting from an impulse applied at another point may be represented as a superposition of traveling plane waves. The phase and period of the disturbance at any instant are related by the principle of stationary phase to the phase and period of a traveling wave component. For the instantaneous phase of that traveling wave component the following equation may be written.

$$\underline{Ct} - \underline{x} = (\underline{N} - \varphi_0/2\pi)\underline{CT}$$

where $\underline{C}$ is the phase velocity, $\underline{x}$ the distance, $\underline{T}$ the period, $\underline{t}$ the travel time, $\underline{N}$ an integer, and φ_0 the initial phase of the traveling wave component. Since $\underline{t}$ and $\underline{T}$ may be measured from a record of the disturbance and $\underline{x}$ may be determined, the equation may be used to compute the phase velocity as a function of period, if the initial phases are known. If distance and the dispersion are known, initial phases may be determined. From distance, initial phases, and phase velocities the disturbance at any point may be constructed. The practical use of the method is demonstrated by application to antisymmetric waves in a cylindrical rod, Rayleigh waves from United States and Russian nuclear explosions, Rayleigh waves from the Hudson Bay earthquake of Jan. 30, 1959, and Love waves from the Fairview Peak and Fallon, Nevada, earthquakes of 1954.

2-645. Knopoff, Leon, Freeman Gilbert, and W. L. Pilant. WAVE PROPAGATION IN A MEDIUM WITH A SINGLE LAYER: Jour. Geophys. Research, v. 65, no. 1, p. 265-278, 3 illus., 7 diags., graph, 2 tables, Jan. 1960, 7 refs.

The generation of Love (SH) waves by an impulsive source located in a medium with a single layer has already been studied. The fine structure of the dispersive Love wave train has been shown to correspond to the superposition of a number of multiple reflections within the surface layer. The propagation of P-SV motions in a layer can be represented in a similar way as the sum of contributions from an infinite set of images of the source taken in the 2 boundaries. A seismic model has been set up to demonstrate the features of the wave propagation. The train of Rayleigh waves is observed to lengthen as the epicentral distance increases. The other important events are the refracted P and S pulse groups; each of these lengthens with increase in epicentral distance. The duration and the envelopes of the refracted P and S events are features not heretofore anticipated. A theoretical investigation based on a quantitative ray theory verifies the existence of these events. The quantitative ray theory is a method by which a number of the problems arising in seismology can be treated without the usual involved mathematical operations. An experimental technique for directly determining the group velocity in a model layered structure is presented. The results of the seismic model agree with the theoretical values.--Auth.

2-646. Pickett, G.R. THE USE OF ACOUSTIC LOGS IN THE EVALUATION OF SANDSTONE RESERVOIRS: Geophysics, v. 25, no. 1, p. 250-274, 6 secs., 12 diags., table, Feb. 1960, 5 refs.

It is shown that acoustic velocities in sandstones are primarily dependent on porosity, shaliness, and pressure differential between overburden and fluid pressures. Although there are undoubtedly other variables which have some effect on acoustic velocities in sandstones, usable porosity predictions can be made from acoustic borehole logs if measured velocities are corrected for effects of pressure differential and shaliness.

A theoretical relation between acoustic velocity and pressure differential in a hexagonal packing of spheres has been empirically extended by correlation of laboratory measurements on cores with actual well-bore measurements. A system of empirical relations among acoustic velocity, porosity, and self potential of sandstones is developed. Further, it appears that the resistivity of water in permeable rocks can be estimated from the velocity and resistivity of adjoining shales. When this is possible, the SP log can then be used to estimate the shaliness of a sandstone in order to correct velocities for porosity estimates.--Auth.

2-647. Musgrave, Albert W., W.C. Woolley, and Helen Gray. OUTLINING OF SALT MASSES BY REFRACTION METHODS: Geophysics, v. 25, no. 1, p. 141-167, 34 figs. incl. 3 illus., 7 maps, 4 charts, 19 diags., Feb. 1960, 4 refs.

Short surface-to-surface refraction lines define the top of a shallow salt dome previously located by reflection methods. A map is made from the results of a number of longer refraction lines radiating from the center of the dome. The increased accuracy of this system is primarily dependent upon the accurate determination of velocities and distances.

Flank wells are used for further refraction shooting which yield more accurate velocity information and more detailed salt profiling. A map from this integrated information permits exploitation at a minimum risk, even though every location is essentially a wildcat.--Auth.

2-648. Philip, J.R. ATMOSPHERIC DIFFUSION AND NATURAL RADON: Jour. Geophys. Research, v. 64, no. 12, p. 2468, Dec. 1959, ref.

Wilkening's attempt to deduce the daily variation of eddy diffusivity from his observations of diurnal and annual cycles of natural Rn concentration near the ground is not entirely satisfactory. The most important objection to his analysis is that he applies a steady-state form of the diffusion equation to a demonstrably transient phenomenon. Thus little reliance can be placed on the quantitative estimates given in his paper.--D. B. Vitaliano (courtesy Geophysical Abstracts).

2-649. Urey, Harold C. CRITICISM OF THE MELTED MOON THEORY: Jour. Geophys. Research, v. 65, no. 1, p. 358-359, Jan. 1960, 7 refs.

Difficulties in Kuiper's hypothesis that an original "accreted crust" floats on a completely melted subcrust in the moon are pointed out. As both crust and molten material are assumed to be of average primitive composition, the denser solid crust should disintegrate and sink into the liquid Further, the age required to produce the melting is greater than present estimates of 5.5×10^9 years, the moon's irregular shape implies substantial mechanical strength, and the assumed melting process (by radiogenic heat) is unrealistic in the light of corresponding terrestrial processes.--D. B. Vitaliano (courtesy Geophysical Abstracts).

7. GEOCHEMISTRY

See also: Stratigraphy 2-591 through 2-595; Geohydrology 2-718; Mineral Deposits 2-727, 2-733, 2-738.

2-650. Vistelius, Andrew B. THE SKEW FREQUENCY DISTRIBUTIONS AND THE FUNDAMENTAL LAW OF THE GEOCHEMICAL PROCESSES: Jour. Geology, v. 68, no. 1, p. 1-22, 9 diags. (8 fold.), 4 graphs, 10 tables, Jan. 1960, 60 refs.

The frequency distribution of concentrations of chemical elements has been investigated. Modern statistical methods for the analysis of large and small samples have been used. As a result of the work, the formulation of the fundamental law of the geochemical processes is proposed. This law can be applied in many cases to the investigation of deposits. The author points out the difference between "the distribution of the concentrations" in V. M. Goldschmidt's sense and "the probability distribution of the concentrations" of the present paper.--Auth.

2-651. Goldsmith, Julian R. EXSOLUTION OF DOLOMITE FROM CALCITE: Jour. Geology, v. 68, no. 1, p. 103-109, 3 illus., diag., table, Jan. 1960, 10 refs.

Calcites from a variety of marbles have been investigated by single-crystal X-ray techniques. Most of the specimens were relatively high-grade metamorphic carbonates, from amphibolite and granulite facies rocks. The typically clouded calcite of these rocks commonly contains dolomite, revealed by the X-ray photographs but not always observed under the microscope. This finely disseminated dolomite is in the same crystallographic orientation as the host calcite and is almost certainly an exsolution product.

An oriented intergrowth of dolomite in calcite was produced in the laboratory. The original material was an echinoid test made up of spongy but single-crystal calcite with approximately 10% $MgCO_3$ in metastable solid solution. This amount of Mg is stable in calcite only at temperatures well above 600°C.; therefore exsolution of some of the Mg as dolomite took place when the sample was heated under CO_2 pressure at 500°C. The host magnesian calcite retained its identity as a single crystal, and the dolomite exsolved in the same crystallographic orientation as the host.

The calcites of many of the metamorphic rocks still have significant amounts of Mg in solid solution; the exsolved dolomite in these cases indicates a higher temperature than would be deduced by the amount of Mg now in solid solution in the calcite.--Auth.

2-652. Koizumi, Mitsue, and Rustum Roy. ZEOLITE STUDIES. I. SYNTHESIS AND STABILITY OF

THE CALCIUM ZEOLITES: Jour. Geology, v. 68, no. 1, p. 41-53, 5 diags., 4 tables, Jan. 1960, 18 refs.

Gels with CaO-Al_2O_3-SiO_2 ratios from 1:1:3 to 1:1:10 were prepared with SiO_2 supplied as the 150 Å-sol "Ludox" and reacted under hydrothermal conditions in sealed systems. The zeolites - heulandite, wairakite, phillipsite, scolecite, and laumontite - were also used as starting materials.

All the Ca zeolites, except laumontite and phillipsite, have been synthesized from the gels. A new zeolite phase, CASH-II, was prepared from the 1:1:3 and 1:1:4 gels. Remarkable phenomena were encountered by seeding the same composition with different zeolites. Natural phases and synthetic gels often gave entirely different results owing to the marked structural control in framework structures at low temperatures.

At 1,000 atm. H_2O pressure, the observed temperature and products of dissociation (many of them metastable) of the zeolites are as follows:

phillipsite → wairakite + H_2O at 260°C.
scolecite → anorthite + wairakite + H_2O at 300°C.
laumontite → wairakite + H_2O at 410°C.
heulandite → wairakite + SiO_2 + H_2O at 320°C.
epistilbite → wairakite + SiO_2 + H_2O at 350°C.
wairakite → anorthite + quartz + H_2O at 465°C.

The results and those from the gels are combined into a possible equilibrium diagram. The p-t curves for the wairakite and heulandite dissociation are presented.--Auth.

2-653. Grushkin, G.G., and P.L. Prikhidko. CHANGES IN CHEMICAL COMPOSITION, CONCENTRATION, AND pH OF GASEOUS-LIQUID INCLUSIONS IN SUCCESSIVE FLUORSPAR SERIES. Translated by V.P. Sokoloff: Internat. Geology Rev., v. 1, no. 12, p. 66-71, graph, 6 tables, Dec. 1959, 6 refs.

Three principal generations of fluorspar (dark violet, violet, and green) are discussed as part of a study on hypogene vein minerals. Spectrographic analysis revealed foreign chemical admixtures, apparently included in fluorspar as it replaced limestone. Occurrence of small quantities of admixtures in later generations agreed with distribution of fluorspar generations in the ore body. Gaseous-liquid inclusions containing alkalies and other solutes were studied microchemically and spectrographically. To determine efficiency of the extraction method, parallel analyses were conducted comparing prolonged to rapid leaching processes. SiO_2, CO_3, NO_3, SO_4, R_2O_3, and Fe^{2+} were absent in the aqueous extraction; Cl, K, Na, and Mg (removed during the first extraction-leaching) generally were absent in later extractions. F, Ca, and HCO_3 were determined by the difference between basic- and control-analysis data. Spectrographic analysis of control specimens was used to ascertain whether extracted salts were present in mineral inclusions. Alkali content of various samples correlated directly with content of included material, demonstrating that alkalies were contained in the inclusions, i.e., not atomically interspersed in the crystal structure. Weight loss in fluorspar, measured by heating and thus exploding inclusions, was greatest between 200 and 400°C.; beyond 400°C. no further weight loss occurred. Analysis indicated that fluorspar-forming solutions changed gradually from alkali chloride and fluoride to sodium and calcium bicarbonate in composition, accompanied by increase in pH. Discovery by one of the authors that gaseous-liquid inclusions obey van der Waals' law, made it possible to determine their composition; consequently, it was possible to group certain types of inclusions, previously considered impossible to subject to combined analysis, under a single category.--D. D. Fisher.

2-654. Ormsby, W.C., and J.M. Shartsis. SURFACE AREA AND EXCHANGE CAPACITY RELATION IN A FLORIDA KAOLINITE: Am. Ceramic Soc., Jour., v. 43, no. 1, p. 44-47, graph, 2 tables, Jan. 1960, 29 refs.

In connection with the study of certain properties of clay-water systems, an investigation was made of the exchange behavior-surface area relations of a series of controlled particle-size (monodisperse) fractions of a domestic kaolin. Surface areas were estimated by application of the Brunauer-Emmett-Teller theory to low-temperature N adsorption isotherms. Similar estimates were made based on room-temperature water adsorption isotherms. Exchange behavior was studied using direct quantitative techniques involving the exchange of divalent Mn. Good correlation was found to exist between the computed Brunauer-Emmett-Teller areas and the exchange capacities over the particle-size range 10 to 0.05μ, equivalent spherical diameter. These results suggest that the exchange behavior in kaolinites is primarily a surface phenomenon and does not depend on isomorphous substitutions.--Auth.

2-655. Vulchin, E.I. CONTRIBUTIONS TO RESEARCH ON QUARTZ-FORMING SYSTEMS. Translated by V.P. Sokoloff: Internat. Geology Rev., v. 1, no. 11, p. 1-27, 13 diags., 7 tables, Nov. 1959, 78 refs.

Investigation of quartz inclusions has yielded data on concentrations, temperatures, and pressures of mineral-forming systems important in application to problems of mineral genesis and prospecting criteria. An integrated method [is described] involving preliminary microscopic examination of inclusions, and analyses of aqueous extracts, and spectrographic analyses of powdered material, both derived from inclusions. Solutions available only in small quantity or of high dilution were subjected to optical-spectrographic and microturbidimetric, qualitative and quantitative analyses. Chemically, the solutions showed alkaline reaction; Na, K, Ca, and Cl were prominent. In secondary inclusions cations Na^+, K^+, Ca^{2+}, Mg^{2+}, Al^{3+}, Fe, and Mn with anions Cl^-, SO_4^{2-} and BO_3^{3-} were present in dissolved state. The presence of B was noted for the first time in analysis, although it is known to be characteristic in quartz-forming solutions. The concentration calculated for dissolved salts ranged from 30 to 35%. Transfer of Si appears to occur through metasilicate anions, SiO^{3-} and Si_2O_5; OH^- is present along with SiO_2 resulting evidently from hydrolysis of SiO_3^{2-}.

PT diagrams of binary systems are used to gage the extent of mineral-formation possibilites. Three-component fields indicate: phase composition of saturated solutions, saturated solutions with gaseous phase, and saturated gaseous solutions. Recurrent metastability phenomena are discussed with respect to their modification of theoretical phase systems. Use of VT diagrams implements calculation of homogenization temperature for included phases by examination of volume-ratio curves for liquid and gaseous phases during heat application. Multicomponent-system PT diagrams are derived from those

describing simpler systems; they are a resultant of the phase interrelationships under consideration. --D. D. Fisher.

2-656. Buckner, Dean A., Della M. Roy, and Rustum Roy. STUDIES IN THE SYSTEM CaO-Al_2O_3--SiO_2-H_2O, II: THE SYSTEM $CaSiO_3$-H_2O: Am. Jour. Sci., v. 258, no. 2, p. 132-147, 3 figs. incl. diags., 2 graphs, 5 tables, Feb. 1960, 26 refs.

Phase equilibria in the system $CaSiO_3$-H_2O were studied, and a p-T curve constructed for the upper stability of xonotlite. The maximum stability of xonotlite is about 420°C. at 20,000 p.s.i. for $CaSiO_3 \cdot 1/5\ H_2O$, but is raised to about 500°C. by the substitution of 7.5 wt. % $SrSiO_3$. At higher contents of $SrSiO_3$ a new anhydrous phase appears, herein called μ-(Ca, Sr)SiO_3. Well-crystallized 11 Å tobermorite, having the composition $4CaO \cdot 5SiO_2 \cdot 5H_2O$ is stable up to about 285°C. at 15-30,000 p.s.i., where it decomposes to xonotlite (+ truscottite? + H_2O). The crystallization of scawtite and its relation to the tobermorite decomposition is discussed. New data on the phases are presented and the petrological and crystallo-chemical significance discussed.--Auth.

2-657. Hemley, J. Julian. SOME MINERALOGICAL EQUILIBRIA IN THE SYSTEM K_2O-Al_2O_3-SiO_2-H_2O: Am. Jour. Sci., v. 258, no. 2, p. 153, Feb. 1960.

In a recent article by J. J. Hemley (GeoScience Abstracts 1-1204) on p. 266 the exponents were omitted from the equilibrium expression. For the reaction as given in the text,

$$K = \frac{a^{1/2}\text{mica}\ aK^+}{a^{3/2}\text{K-feldspar}\ aH^+}$$

The constant corresponding to this overall expression is fixed, although the $^aK^+/^aH^+$ value changes with change in composition of the solid phases.

On p. 259 the dissociation expression for HCl should be

$$K_{HCl} = \frac{a_{H^+}\ a_{Cl^-}}{m_{HCl} - \frac{a_{H^+}}{0.1}} = 7.0 \cdot 10^{-3}\ .$$

As shown, the mean activity ratio of KCl/HCl is then $\frac{a_{H^+}}{a_{K^+}} = 10^{2.89}$.--Auth.

2-658. Hahn, W. C., Jr., and Arnulf Muan. STUDIES IN THE SYSTEM Mn-O: THE Mn_2O_3-Mn_3O_4 AND Mn_3O_4-MnO EQUILIBRIA: Am. Jour. Sci., v. 258, no. 1, p. 66-78, 2 diags., 3 tables, Jan. 1960, 27 refs.

As a first step in an investigation of phase relations in the system Mn-O, the equilibria 6 Mn_2O_3 = 4 Mn_3O_4 + O_2 and 2 Mn_3O_4 = 6 MnO + O_2 have been studied in the temperature intervals 845 to 1029°C. and 1248 to 1562°C., respectively, and at O_2 partial pressures ranging from 0.21 to 1 atm. and from $10^{-3.66}$ to 0.21 atm. respectively. The conditions for coexistence of 2 crystalline phases in stable univariant equilibria are expressed as follows:

Mn_2O_3, Mn_3O_4 : $\log p_{O_2} = 8.05 - 10100 \cdot 1/T$
Mn_3O_4, MnO : $\log p_{O_2} = 13.31 - 26000 \cdot 1/T$

Exploratory runs in the solidus temperature region for the composition range between MnO and Mn_3O_4 indicate the presence of a eutectic at approximately 1540°C.

An explanation is offered for the poor agreement among previously published data on these equilibria.--Auth.

2-659. Geller, Seymour, and C. E. Miller. SILICATE GARNET - YTTRIUM-IRON GARNET SOLID SOLUTIONS: Am. Mineralogist, v. 44, no. 11/12, p. 1115-1120, 3 graphs, 2 tables, Nov.-Dec. 1959, 9 refs.

In the system $Ca_3Al_2(SiO_4)_3$ - $Y_3Fe_2(FeO_4)_3$, a series of solid solutions exists over the range 10-100% $Y_3Fe_2(FeO_4)_3$. Similar to the system spessartite - yttrium-aluminum garnet, this system does not follow a linear composition vs. lattice constant law. Under the conditions of the experiments, a complete series of solid solutions does not exist in the system $Mn_3Al_2(SiO_4)_3$ - $Y_3Fe_2(FeO_4)_3$ although there is some solution at the ends. The system $Ca_3Al_2(SiO_4)_3$ - $Gd_3Fe_2(FeO_4)_3$ is similar to that of the $Ca_3Al_2(SiO_4)_3$ - $Y_3Fe_2(FeO_4)_3$ system but under similar experimental conditions does not appear to have as wide a range.--Auth.

2-660. Nichiporuk, Walter, and Arthur A. Chodos. THE CONCENTRATION OF VANADIUM, CHROMIUM, IRON, COBALT, NICKEL, COPPER, ZINC, AND ARSENIC IN THE METEORITIC IRON SULFIDE NODULES: Jour. Geophys. Research, v. 64, no. 12, p. 2451-2463, diag., 11 tables, Dec. 1959, 29 refs.

The concentrations (based on graphite-free nodules) of V, Cr, Co, Ni, Cu, Zn, and Fe have been determined by X-ray fluorescence analysis in 22 troilite nodules from 12 Fe and 2 silicate meteorites. These elements were determined, in addition, in the del Norte County, California, terrestrial troilite.

It was found that the concentration ranges of the elements are extremely broad and do not differ greatly for the 3 types of troilites studied.

The elements Cr and Ni, which are present in the largest concentrations, are distributed over the ranges which also appear to be the broadest. The Cu range is the narrowest, and the Co range is comparable to that of Ni. Since in most cases concentrations of V, Zn, and As lie below the respective detection limits, the effective concentration ranges for these elements may be as broad as, if not broader than, the ranges for the other elements. The content of Fe varies within wider limits than those defined by all Fe values previously reported.

An abundant free-Fe phase which occurs in troilite nodules indicates that a complete segregation of the iron sulfide and Fe phases was not attained.--Auth.

2-661. Junge, C. E. SULFUR IN THE ATMOSPHERE: Jour. Geophys. Research, v. 65, no. 1, p. 227-237, 2 maps, graph, 8 tables, Jan. 1960, 13 refs.

In unpolluted areas S occurs primarily in 3 compounds, $SO_4^=$ in aerosols and SO_2 and H_2S as gas. Sources of $SO_4^=$ are the ocean, the soil, and the oxidation of the gaseous compounds. A considerable fraction of the SO_2 is of anthropogenic origin. As measurements in polluted and unpolluted areas indicate, most of the H_2S seems to be natural. In unpolluted air in the northeastern part of the United States, both gases have approximately equal concentrations. The chemistry of the conversion of these gases to $SO_4^=$ is discussed.

Estimates of the S budget of the global atmosphere, excluding the $SO_4^=$ in sea salt particles, indicate that 30% is of anthropogenic origin. Measurements of the chemical composition of Greenland ice back to the year 1915 are presented. The measurements show that the concentration of $SO_4^=$ is much higher than that of other soluble constituents,

but it has not increased since 1915 as much as one would expect if it were of industrial origin. It is concluded that industrial S is removed from the atmosphere before it spreads to polar regions. This is consistent with estimates of the residence time of about 5 days for SO_2 and about 40 days for total S.

Convay showed that more SO_2 enters the oceans with river water than can be accounted for by the weathering of rocks and sediments on land and that the excess must come from the atmosphere. He assumes a closed S cycle and suggests that this S must return to the atmosphere as H_2S, produced in the shelf areas of the oceans. In view of the considerable amounts of industrial S, it is possible that the global S cycle is not closed and that most of the excess S in river waters is of the anthropogenic origin and will stay in the ocean.--Auth.

2-662. Gerasimovsky, V.I. GEOCHEMISTRY OF RARE EARTH ELEMENTS. Translated by Research International: Internat. Geology Rev., v. 1, no. 12, p. 72-79, map, graph, 2 tables, Dec. 1959, 21 refs.

Although called rare earths, elements La (atomic number 57) through Lu (atomic number 71) on the periodic table, including Y (atomic number 37), are more common in nature than are many of the industrially important nonferrous metals. The rare-earth elements occur in oxide, silicate, phosphate, and carbonate compounds or as small fractions replacing Ca and Sr, whose ionic radii are similar to those of the rare-earth elements. Rare-earth minerals are more commonly found in pegmatites, granites, and nepheline syenites. Further study of the rare earths will aid geochemical prospecting, determination of mineralization processes, and clarification of geologic processes, as well as augmentation of alloy-metal reserves and product differentiation.--Translator.

2-663. Hall, Wayne E. GEOCHEMICAL STUDY OF Pb-Ag-Zn ORE FROM THE DARWIN MINE, INYO COUNTY, CALIFORNIA: Mining Engineering, v. 11, no. 9, p. 940, Sept. 1959, ref.

An analysis to determine 1) the distribution of Bi, Se, and Ag in galena samples, and 2) the temperature range of ore formation.

The Se in 21 samples of galena ranges from 0.0045 to 2.11%; 4 contain more than 1%. The Se-bearing galena also contains concentrations of Bi and Ag. Preliminary spectrographic analyses indicate as much as 3% Bi and more than 1% Ag in galena with high Se content. Sb is the only other minor element present in galena in amounts greater than 0.02%; most galena contains between 0.1 and 0.2% and the maximum is 0.72%.

Preliminary results indicate temperature range from 430°C. in replacement ore bodies in the Defiance workings to 180°C. in shallow fissure fillings. --A. C. Sangree.

2-664. Weber, Jon N. GEOCHEMISTRY OF GRAYWACKES AND SHALES: Science, v. 131, no. 3401, p. 664-665, table, March 1960.

Sixty-nine graywackes and 33 shales were analyzed spectrographically for 14 minor elements to illustrate the variation of composition within a graywacke bed, between beds in one section, between sections, and between formations. Analyses of several fractions of a graywacke indicate what each contributes chemically to the rock.--Auth.

2-665. Barkley, Richard A., and Thomas G. Thompson. DETERMINATION OF CHEMICALLY COMBINED IODINE IN SEA WATER BY AMPEROMETRIC AND CATALYTIC METHODS: Anal. Chemistry, v. 32, no. 2, p. 154-158, 4 figs., Feb. 1960, 21 refs.

I, in the form of iodides and iodates in sea water, may be determined directly in relatively small samples in much less time and with elimination of loss of I inherent in other methods. The amperometric method permits ready determination of I in the form of iodate and iodide. The catalytic method permits determination of total I more rapidly and accurately than the amperometric method. The difference between the total I and the iodate-iodine gives the iodide-iodine. Some data are given for the distribution of I in the NE. Pacific.--R. A. Bisque.

2-666. Young, B.G., and Harry G. Thode. ABSOLUTE YIELDS OF THE XENON AND KRYPTON ISOTOPES IN U^{238} SPONTANEOUS FISSION: Can. Jour. Physics, v. 38, no. 1, p. 1-9, diag., graph, 4 tables, Jan. 1960, 15 refs.

The absolute abundances ot the isotopes of fission-product Xe and Kr in 6 U minerals have been determined mass spectrometrically using the isotope dilution technique. The fission products were resolved into a U^{238} spontaneous fission component, a U^{235} neutron-induced fission component, and a U^{238} neutron-induced fission component. Internal consistency in the analysis was achieved only when the Xe^{129} yield used for the U^{235} thermal neutron fission component was 20% lower than that reported by Purkayastha and Martin at I^{129}. This discrepancy in the mass 129 chain yield measured at I^{129} and at Xe^{129} has not been resolved.

Only 1 of the 6 minerals, Cinch Lake pitchblende, retained essentially all of its fission product inert gases throughout geological time. Inert gas losses from the remaining 5 minerals ranged from 20% to 75%. The absolute yields of the stable Xe and Kr fission products in U^{238} spontaneous fission were determined from an analysis of the inert gases from the Cinch Lake mineral. This analysis showed that 95.9% of the fission gas in this case resulted from the spontaneous fission and only 4.1% from neutron-induced fission.--Auth.

2-667. Lyon, R.J.P. TIME ASPECTS OF GEOTHERMOMETRY: Mining Engineering, v. 11, no. 11, p. 1145-1151, 6 figs. incl. illus., chart, 3 graphs, table, Nov. 1959, 20 refs.

There are marked discrepancies in depositional times derived from laboratory diffusion studies on naturally intergrown sulfides and those considered likely for most ore-forming processes, particularly where ores are formed or modified by regional metamorphism. Schwartz decided in 1931 that 475°C. was the minimum temperature at which he could restore completely the solid solution from natural bornite-chalcopyrite intergrowths, but he also stated that reformed intergrowths could be preserved only if the time of cooling from 475°C. to room temperature was less than 24 hours. The present article discusses the diffusion rates in 2 Australian ores that have been studied in detail. In Pine Vale ore, bornite, chalcopyrite, and tetrahedrite occur intergrown in fixed proportions. Heat treatment restores a homogeneous solid solution at 500°C. in 100 hours. The pattern of natural intergrowths can be simulated only if that solid solution is

chilled to below 275°C. in a few minutes. The ore must have been introduced 200°to 250°C. hotter than that of the country rock and frozen in place.

In Aberfoyle ore, sphalerite, stannite, and chalcopyrite each occur containing the other 2 as intergrowths. Data obtained from the Fe content of the sphalerite and from heat treatment of the ore indicate that deposition occurred at about 600°C. Chilling by the country rock had arrested the unmixing of the 3 blend-group solid solutions. Annealing experiments above 350°C. led to further precipitation from the solid solutions and to significant segregation by solid diffusion within one week, indicating that both deposition and cooling of the ore were rapid processes - completed in a matter of days. The possibility that there are unsuspected variables in the diffusion experiments should be investigated.--Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Sedimentary Petrology 2-706, 2-710, 2-716; Mineral Deposits 2-725, 2-738.

2-668. Michigan Mineralogical Society. SPECIAL MINERAL ARRANGEMENTS AND DISPLAYS: Its: Pub. no. 4, 11 p., 4 illus., 2 diags., 1959.

Special mineral displays and arrangements developed by the Michigan Mineralogical Society are described. These include fluorescence display, transparency display, a special wax (Andover formula) for mounting gems for display, gem displays, thumb nail displays, vial displays, micromount displays, and general displays.--M. Russell.

2-669. Lewis, Donald R., Thomas N. Whitaker, and Carl W. Chapman. THERMOLUMINESCENCE OF ROCKS AND MINERALS. PART I. AN APPARATUS FOR QUANTITATIVE MEASUREMENT: Am. Mineralogist, v. 44, no. 11/12, p. 1121-1140, 7 diags., 2 graphs, 2 tables, Nov.-Dec. 1959, 16 refs.

Equipment which permits quantitative recording of the thermoluminescence emitted by samples with a high degree of reproducibility and sensitivity has been developed. The equipment operates over the temperature range from 25°C. to 600°C. at rates from 10°C. per minute to 100°C. per minute. The apparatus has high light-detection sensitivity and broad spectral response. The construction combines reliability and flexibility with simplicity of operation. Not more than 50 milligrams of sample is ordinarily required.

An analysis of the instrumental and physical factors which determine the precision of making glow curves is made to evaluate the requirements for each section of the apparatus.--Auth.

2-670. Wilcox, Ray E. USE OF THE SPINDLE STAGE FOR DETERMINATION OF PRINCIPAL INDICES OF REFRACTION OF CRYSTAL FRAGMENTS: Am. Mineralogist, v. 44, no. 11/12, p. 1272-1293, 5 figs. incl. 3 diags., graph, table, Nov.-Dec. 1959, 28 refs.

A small crystal or crystal fragment mounted on the tip of a spindle in a suitable holder on the polarizing microscope stage may be oriented quickly and accurately for measurement of all its principal indices of refraction by the immersion method. Independent measurements or estimations of other properties, such as optic angle, optic sign, dispersion, pleochroism, and the relation of the indicatrix to cleavage or crystal faces may be made on the same fragment. Besides its usefulness in determinative mineralogy, this inexpensive device has much to recommend it as a teaching aid in optical crystallography, since, with its help, the student rapidly acquires facility and confidence in the application of interference figures and extinction angles to mineralogic and petrographic problems. The device used here is based on that of Rosenfeld but is of somewhat more rugged construction and provides for reading of angular rotations about the spindle axis. For mounting the fragment a mixture of ordinary carpenter's glue and molasses is recommended. Either orthoscopic or conoscopic illumination may be used to orient the fragment for measurement of its principal indices. The orthoscopic procedure can give results to the limit of accuracy of the immersion method employed, while the conoscopic procedure is usually faster and gives results sufficiently accurate for all but the most exacting work, besides providing additional optical information.--Auth.

2-671. Raeside, James D. STABILITY OF INDEX MINERALS IN SOILS WITH PARTICULAR REFERENCE TO QUARTZ, ZIRCON, AND GARNET: Jour. Sed. Petrology, v. 29, no. 4, p. 493-502, illus., table, Dec. 1959, 52 refs.

In soil studies a group of index minerals has been generally accepted as sufficiently stable to be used as the basis for evaluating changes in soil profiles. Three of the minerals, quartz, garnet, and zircon, are shown to be susceptible to physical breakdown through strain caused by crystal disorientation or crystalline inclusions. Some varieties of garnet are susceptible to weathering, notably those with high Fe content, and both quartz and zircon may be susceptible to solution. These minerals should , therefore, be used only in circumstances where physical or chemical changes can be excluded and where the minerals are free from crystalline inclusions and strain.--Auth.

2-672. Stemple, Irene S., and George W. Brindley. A STRUCTURAL STUDY OF TALC AND TALC-TREMOLITE RELATIONS: Am. Ceramic Soc., Jour., v. 43, no. 1, p. 34-42, 6 figs. incl. illus., diags., 3 tables, Jan. 1960, 8 refs.

About 40 specimens of talc have been examined by X-ray powder methods. Variations in the degree of crystallinity of the mineral have been observed, but no evidence has been obtained for polymorphic structural varieties. Single-crystal data have confirmed the 2-layer monoclinic cell. Little evidence has been obtained of talcs containing mixed-layer sequences. Electron micrographs have revealed a variety of platy and fibrous forms, and in the latter a close structural relation between talc and tremolite has been established. Talcs prepared synthetically in the presence of Al showed small lattice parameter differences from talcs prepared in the absence of Al, and the results are consistent with the substitution of small percentages of Al ions in the talc structure. New X-ray powder data and unit-cell parameters for talc and tremolite are listed.--Auth.

2-673. Wright, Harold D. AN OPTICAL STUDY OF TALC-TREMOLITE RELATIONS: Am. Ceramic Soc., Jour., v. 43, no. 1, p. 42-43, illus., table, Jan. 1960, 3 refs.

An optical study of talc-tremolite from Fullerville, St. Lawrence County, New York, confirmed the crystallographic orientation determined by Stemple and Brindley (see above). Both minerals exhibit normal optic properties. The optic orientation of talc given in standard references appears to be in error.--Auth.

2-674. Evans, Howard T., Jr., and Edwin T. McKnight. NEW WURTZITE POLYTYPES FROM JOPLIN, MISSOURI: Am. Mineralogist, v. 44, no. 11/12, p. 1210-1218, 3 illus., 3 tables, Nov.-Dec. 1959, 13 refs.

Small, hemimorphic hexagonal crystals implanted on botryoidal zinc sulfide from the Zig Zag Mine, Joplin, Missouri, have been studied by crystallographic and X-ray diffraction techniques. They are identified as a new wurtzite polytype, wurtzite-10H. The unit cell data are: space group, $P6_3mc$; a = 3.824 Å, c = 31.20 Å; cell contents, 10ZnS. Comparison of diffraction intensity data indicates that the published structure of SiC-10H (stacking sequence 3223) is different from that of wurzite-10H. Calculation of intensities for various models shows that the stacking sequence for wurtzite-10H is 55. Crystals of wurtzite from Joplin described by A. F. Rogers were evidently wurtzite-10H. Powder diffraction data revealed the presence of another polytype, wurtzite-8H, with a hexagonal unit cell: space group $P6_3mc$; a = 3.82 Å, c = 24.96 Å; cell contents 8ZnS. Wurtzite-6H was also found at the Zig Zag Mine. The wurtzite polytypes evidently form a homologous series (2H, 4H, 6H, 8H, 10H) resulting from growth phenomena based on screw dislocations.--Auth.

2-675. Clark, Joan R., Mary E. Mrose, A. Perloff, and G. Burley. STUDIES OF BORATE MINERALS (VI): INVESTIGATION OF VEATCHITE: Am. Mineralogist, v. 44, no. 11/12, p. 1141-1149, fig., 3 tables, Nov.-Dec. 1959, 6 refs.

Veatchite is a hydrated strontium borate originally described by Switzer. In the present study X-ray precession patterns have been correlated with crystal habit and indices of refraction to yield the following data: monoclinic, space group $A2/a\text{-}C_{2h}^6$ (or less likely, $Aa\text{-}C_s^4$), a = 20.81 ± 0.04, b = 11.74 ± 0.03, c = 6.637 ± 0.02 Å, β = 92°02' ± 05', V = 1620 Å^3; dominant forms {100}, {111}, {h11} with h = 2, 3, 4; cleavage perfect parallel to (100) and (011); optical orientation Z = b, X = c, Y ∧ a = −2°. Previous chemical analyses considered together with the present crystallographic data show that the correct formula is $SrO \cdot 3B_2O_3 \cdot 2H_2O$, 1 of 2 possibilities proposed by Switzer and Brannock. For eight $[SrO \cdot 3B_2O_3 \cdot 2H_2O]$ per cell, the calculated density is 2.86 g.cm.$^{-3}$; an observed density of 2.78 ± 0.03 g.cm.$^{-3}$ was obtained on the Berman balance for a 2.4 mg. sample of excellent single crystals. X-ray powder pattern data are given with calculated interplanar spacings for d ≥ 2.300 Å.--Auth.

2-676. Clark, Joan R., and C. L. Christ. STUDIES OF BORATE MINERALS (VII): X-RAY STUDIES OF AMMONIOBORITE, LARDERELLITE, AND THE POTASSIUM AND AMMONIUM PENTABORATE TETRAHYDRATES: Am. Mineralogist, v. 44, no. 11/12, p. 1150-1158, 5 tables, Nov.-Dec. 1959, 5 refs.

Synthetic ammonioborite and the ammonium and potassium pentaborate tetrahydrates have been studied by X-ray single-crystal techniques. The results for the tetrahydrates are in agreement with those presented by Cook and Jaffe. Ammonioborite is monoclinic $C2/c\text{-}C_{2h}^6$ (or less likely, $Cc\text{-}C_s^4$), with a = 25.27 ± 0.05, b = 9.651 ± 0.03, c = 11.56 ± 0.03 A; β = 94°17.5' ± 05'. Instead of $(NH_4)_2O \cdot 5B_2O_3 \cdot 5H_2O$, the ammonioborite formula proposed here is $(NH_4)_2O \cdot 5B_2O_3 \cdot 5\,1/3H_2O$; this gives the best agreement with present chemical and crystallographic data. Indexed X-ray powder data are given for the 3 substances named above; observed powder data are given for larderellite.--Auth.

2-677. Hamilton, Peggy-Kay, and Paul F. Kerr. UMOHOITE FROM CAMERON, ARIZONA: Am. Mineralogist, v. 44, no. 11/12, p. 1248-1260, 3 figs., 3 tables, Nov.-Dec. 1959, 4 refs.

Studies indicate that the hydrous uranium-molybdate, umohoite, is a more widely distributed mineral than has been previously known. The original crystalline material was found at Marysvale, Utah. Similar crystalline material has since been reported by Coleman and Appleman from the Gas Hills district, Wyoming. Recently a new occurrence in a fine-grained form has been discovered at Cameron, Arizona. A similar fine aggregate has been recognized in recently collected material from Marysvale. The identification of fine-grained umohoite has also been confirmed from an undisclosed locality in the U.S.S.R.

The change in lattice dimensions under X-ray bombardment or variable conditions of humidity and temperature has constituted a problem in the X-ray diffraction study of this mineral. In order to overcome this difficulty, the adsorption of the large ethylene glycol molecule into the water positions has been utilized to stabilize the umohoite structure. This may be accomplished without destruction of the structure.

Three coexistent structural modifications are recognized in umohoite. These are designated Modes 1, 2 and 3. The modes range in intensity of development as shown by X-ray diffraction. In fine-grained umohoite (Cameron, fine Marysvale, and U. S. S. R.) Modes 2 and 3 are better developed than Mode 1. In coarser Marysvale umohoite Mode 1 is more prominent than Modes 2 and 3. The coexistence in the same mineral of 3 systematic sequences of lattice variation (or modes), each exhibiting a range in crystallinity in response to physical conditions, is an unusual mineralogical feature.--Auth.

2-678. Hutton, C. Osborne. YAVAPAIITE, AN ANHYDROUS POTASSIUM, FERRIC SULPHATE FROM JEROME, ARIZONA: Am. Mineralogist, v. 44, no. 11/12, p. 1105-1114, 2 figs., 6 tables, Nov.-Dec. 1959, 4 refs.

Yavapaiite, a new mineral from Jerome, Arizona, has the composition $KFe^{3+}(SO_4)_2$ with 2 formula units in the unit cell. The mineral, associated with S, voltaite, and other unidentified sulfates, forms pale pink, brittle, adamantine crystals, elongate parallel to [010], with perfect {100}, {001}, and distinct {110} cleavages, and strong conchoidal fracture. The forms c {001}, d {101}, f {201}, a {100}, and m {110} appear to be most frequently developed. H = 2 1/2-3, S.G. = 2.88 (meas.), 2.92 (calc.); α = 1.593, β = 1.684, γ = 1.698, γ − α = 0.105; $2V_{Na}$ = 30.5° (−), ρ > v strong;

b = Z, c∧X = 6°, a = Y, or nearly so. a_0 = 8.12 Å, ± 0.01 Å, b_0 = 5.14 Å, c_0 = 7.82 Å, β = 94° 24'; $a_0 : b_0 : c_0$ = 1.5795:1:1.5214. Measured cell weight = 936.41 X 10^{-24} gms. Monoclinic, with space group C2, C2/m, or Cm. Decomposed in boiling water, but readily soluble in HCl to give stable solutions.

The mineral is named for the Indian tribe that inhabits that part of Arizona in which the inactive mining center of Jerome is situated.--Auth.

2-679. Heinrich, E. Wm., and A. F. Corey. MANGANIAN ANDALUSITE FROM KIAWA MOUNTAIN, RIO ARRIBA COUNTY, NEW MEXICO: Am. Mineralogist, v. 44, no. 11/12, p. 1261-1271, 3 figs. incl. map, 5 tables, Nov.-Dec. 1959, 31 refs.

Manganian, ferrian andalusite (viridine) occurs abundantly in kyanite-hematite quartzite of the Precambrian Kiawa Mountain formation at Kiawa Mountain, Rio Arriba County, New Mexico. Its extraordinary pleochroism (golden yellow to emerald green) results from the co-presence of Mn^{+3}(Mn_2O_3=4.5%) and Fe^{+3}(Fe_2O_3 = 3.0%). The andalusite apparently formed essentially contemporaneously with the kyanite.--Auth.

2-680. Smith, Joseph V., and W.S. MacKenzie. THE ALKALI FELDSPARS V. THE NATURE OF ORTHOCLASE AND MICROCLINE PERTHITES AND OBSERVATIONS CONCERNING THE POLYMORPHISM OF POTASSIUM FELDSPAR: Am. Mineralogist, v. 44, no. 11/12, p. 1169-1186, 13 figs. incl. illus., graphs, table, Nov.-Dec. 1959, 23 refs.

The observations recorded in paper 1 of this series have been extended to cover 37 specimens of orthoclase and microcline perthites. The exsolved Na phase of the perthitic specimens is usually a low temperature albite or oligoclase, although some specimens falling near the composition Or_{80}(Ab + An)$_{20}$ and with 2V between 50° and 70° contain an anorthoclase instead. The anorthoclase occurs as a pericline twin-type superstructure. Most of the albite-oligoclases are dominantly albite twinned: 4 specimens show both pericline and albite twinning, while 7 specimens with compositions ~Or_{70} and $2V_\alpha$ between 60° and 80° show mainly albite twin-type superstructure.

The potassium phase is monoclinic in 14 specimens, triclinic in 4 and partly each in 15 specimens. The triclinic components give reflections that vary from sharp to diffuse, with lattice angles α^*, γ^* varying from 90°, 90° to about 90°24', 92°20'. All the triclinic components are composed of 2 or more units whose angular relations vary between the extremes of albite and pericline twinning, with the "diagonal" association fairly common.

The optic axial angles fall either in or close to a triangle formed by the 3 extreme varieties: low albite, Or_0 $2V_\alpha$ 100°; orthoclase, Or_{100} $2V_\alpha$ 35°; and maximum microcline, Or_{100} $2V_\alpha$ 80°. There is a moderate, but not good, correlation between the position of the specimens in this triangle and the nature of the K-rich component. Specimens which either contain anorthoclase or consist predominantly of the albite twin-type superstructure of low albite-oligoclase fall into 2 small areas in the 2V versus composition diagram. The preferential occurrence of the superstructure in the more K-rich compositions supports the hypothesis that strain favors its existence in orthoclase and microcline perthites. The anorthoclase is thought to occur because the containing specimens have compositions that lie close to a phase boundary, a condition known to favor metastability.--Auth.

2-681. Emeleus, C.H., and Joseph V. Smith. THE ALKALI FELDSPARS VI. SANIDINE AND ORTHOCLASE PERTHITES FROM THE SLIEVE GULLION AREA, NORTHERN IRELAND: Am. Mineralogist, v. 44, no. 11/12, p. 1187-1209, 12 figs. incl. illus., map, graphs, 4 tables, Nov.-Dec. 1959, 22 refs.

Detailed field and mineralogical studies of the associated porphyritic felsite and granophyre ring dikes of Slieve Gullion, N. Ireland, have been made to elucidate the genesis of the rock and of the alkali feldspars. Central, acentric subsidence of country rock within the ring fracture allowed the partially-crystalline magma to rise. Upon crystallization of 1/3 of the magma the roof shattered to form agglomerate, and the loss of volatiles led to rapid crystallization of the felsite. A subsequent subsidence without roof shattering led to formation of the granophyre.

The majority of the alkali feldspar phenocrysts fall between the sanidine and orthoclase series, consisting of intergrowths of monoclinic K-feldspar, anorthoclase and Na-rich plagioclase. Two crystals from the granophyre consist of intergrowths of orthoclase, microcline and low-temperature plagioclase. It is thought that the majority of the phenocrysts are true phenocrysts formed slowly at considerable depth. During the cooling period they changed from homogeneous sanidine into their present assemblages through a sequence of unmixing and ordering reactions. It is thought that the local content of volatiles was probably the dominant factor in determining the extent of adjustment to the low-temperature assemblages. The occurrence of microcline is remarkable in hypabyssal rocks. It is thought probable that it results from fragments of Newry granodiorite caught up in the magma, although it might have arisen from plagioclase crystals by ionic exchange.--Auth.

2-682. McAtee, James L., Jr., and Charles B. Concilio. EFFECT OF HEAT ON AN ORGANO-MONTMORILLONITE COMPLEX: Am. Mineralogist, v. 44, no. 11/12, p. 1219-1229, 9 graphs, Nov.-Dec. 1959, 6 refs.

An organo-montmorillonite was heated under atmospheres of air, O, and N, while following the changes in the basal spacing with a heating-oscillating X-ray diffractometer.

It has been shown that up to a temperature of about 180°C. a reversible expansion of the basal spacing takes place. With further heating this is followed by a very rapid collapse to a single organic layer between each 2 montmorillonite plates. Further heating reduces this to a system comprised of a monolayer of C between each 2 plates and then finally to a decrease in spacing to 9.8 Å, a fully collapsed montmorillonite.--Auth.

2-683. McAtee, James L., Jr. INORGANIC-ORGANIC CATION EXCHANGE ON MONTMORILLONITE: Am. Mineralogist, v. 44, no. 11/12, p. 1230-1236, 7 graphs, Nov.-Dec. 1959, 3 refs.

Replacement of the inorganic cations on montmorillonite by base exchange with organic compounds has been followed by step-wise additions of the organic compound to the clay. It has been shown that a primary amine has enough basic character to react with montmorillonite by the base exchange mechanism. Data are also given showing the replacement of Na,

Ca, and Mg for montmorillonite and hectorite treated with a large quaternary ammonium salt. The Na on montmorillonite is replaced stoichiometrically while Ca and Mg require greater than the stoichiometric amount of organic for replacement.--Auth.

2-684. Wada, Koji. AN INTERLAYER COMPLEX OF HALLOYSITE WITH AMMONIUM CHLORIDE: Am. Mineralogist, v. 44, no. 11/12, p. 1237-1247, 6 graphs, Nov.-Dec. 1959, 7 refs.

An NH_4Cl-halloysite complex with a basal spacing of 10 Å was prepared by drying halloysite from an NH_4Cl solution or by dry mixing it with NH_4Cl crystals. In addition to the change in basal spacing, orientation of NH_4Cl between the silicate layers caused variations in the relative intensities and peak shapes of some of the hk bands. The oriented NH_4Cl no longer gives X-ray reflections, as does the normal salt, and shows some distinctive features, such as loss of the transformation at 185°C., and the shift of the thermal decomposition to a temperature 30 to 50°C. higher. The orientation maximum of NH_4Cl is estimated at 325 to 330 m. mols. per 100 gms. of air-dried clay (2 molecules of NH_4Cl per unit cell of halloysite). Two molecules of the interlayer water are replaced by one molecule of NH_4Cl in the first stage of the complex formation.--Auth.

2-685. Allen, Victor T., and William D. Johns. CLAYS AND CLAY MINERALS OF NEW ENGLAND AND EASTERN CANADA: Geol. Soc. America, Bull., v. 71, no. 1, p. 75-85, map, table, Jan. 1960, 35 refs.

Clay minerals were collected from shales and clay deposits in New England and Eastern Canada ranging in age from Precambrian to Recent. The collection was made to include representative clay minerals of each district, geological period, and environment. Fifty-six samples were selected for detailed petrographic and X-ray study. The potash clay minerals, or hydrous micas, and chlorite are the abundant clay minerals in the marine shales examined. The hydrous micas, chlorite, or vermiculite are the abundant clay minerals in the varved clays of nonmarine origin and clays containing marine fossils of Quaternary age. Clay from glacial till also contains potash clay minerals and vermiculite. The source material had a greater influence on the clay-mineral composition than the environment in which the clay minerals were deposited. The clays and shales that contain abundant kaolinite were apparently deposited under nonmarine conditions. They were eroded from kaolinite clays formed by surface weathering or by hydrothermal replacement. Kaolinite deposits attributed to these processes occur in this region.--Auth.

2-686. Lester, James G. GEM MINERALS OF GEORGIA: Emory Univ. Quart., v. 15, no. 3, p. 160-167, Oct. 1959.

After a brief gemological dissertation, a list of gemstones found in Georgia is furnished along with some localities for a selected few.--J. Sinkankas.

2-687. Smirnov, G.I. MINERALOGY OF SIBERIAN KIMBERLITES. Translated by Royer & Roger, Inc.: Internat. Geology Rev., v. 1, no. 12, p. 21-39, 4 illus., 8 graphs, 22 tables, Dec. 1959, 8 refs.

Siberian kimberlite minerals are classified according to their occurrence and origin as: 1) kimberlite minerals - associated directly with kimberlite formation (pyrope, ilmenite, olivine, magnetite, diopside and chrome-diopside, chrome-spinel, perovskite, micas, and enstatite and hypersthene); 2) xenolithic minerals - either directly related to kimberlites by chemical composition or in association with this group, but compositionally unrelated to the kimberlites; and 3) secondary minerals - formed in secondary alteration of kimberlite principally by serpentinization and carbonitization, and, to a lesser degree, by silicification, chloritization, and pyritization processes. Mineral specimens under investigation were taken at depths not exceeding 3 to 4 m.; thus, they indicate known composition for only the uppermost portion of the kimberlite pipes. Basically Siberian and South African kimberlites are similar. Between the 2 areas, there is little variation in mineral composition; quantitative differences exist locally, governed by conditions surrounding mineral formation. Mg content in pyrope, olivine, diopside, ilmenite, etc., is high in both kimberlites. In addition, both areas have undergone extensive secondary alteration by comparable processes.--D. D. Fisher.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Structural Geology 2-560, 2-562; Stratigraphy 2-585; Mineralogy 2-680, 2-681, 2-687.

2-688. Cook, Earl F. IGNIMBRITE BIBLIOGRAPHY: Idaho, Bur. Mines & Geology, Inf. Circ. no. 4, 30 p., Aug. 1959.

In recent years many rhyolitic and dacitic sheets have been recognized as ignimbrites (welded tuffs, tuff lavas) instead of lava flows. This type of rock unit is the subject of an increasing amount of research. This bibliography of 274 items includes papers in which ignimbrites are described or mentioned, as well as those in which the possible mechanism of emplacement of such rocks is discussed. The alphabetical listing by author is supplemented by both geographic and subject indexes.--Auth.

2-689. Blokhina, L.I., V.S. Koptev-Dvornikov, M.G. Lomize, M.A. Petrova, E.I. Tikhomirova, I.I. Frolova, and E.B. Yakovleva. PRINCIPLES OF CLASSIFICATION AND NOMENCLATURE OF THE ANCIENT VOLCANIC CLASTIC ROCKS. Translated by Research International: Internat. Geology Rev., v. 1, no. 12, p. 56-61, table, Dec. 1959, 17 refs.

Volcanic clastic rocks comprise various rocks of clastic texture, formed as a result of volcanic activity. Classification of these rocks should be based, in the first place, on petrographical characteristics, which are possible to determine macro- and microscopically. In the suggested classification, volcanic clastic rocks are subdivided into 4 groups according to the composition of cementing mass and to the relative contents of pyroclastic and sedimentary material, namely: lava breccias, pyroclastic rocks (welded tuffs, tuffs, volcanic breccias), essentially pyroclastic rocks (tuffites) and pyroclastic-sedimentary (tuffogenic-sedimentary) rocks. Further sub-

division of the rocks depends on their granulometric composition, chemico-petrographical composition, and also on homogeneity or heterogeneity of the clastic material. In some cases there are also taken into account the relative contents of vitric, crystal, and lithic pyroclastic material and the degree of abrasion and sorting of the fragments.--Translator.

2-690. Dietrich, Richard V. NOMENCLATURE OF MIGMATITIC AND ASSOCIATED ROCKS: GeoTimes, v. 4, no. 5, p. 36-37, 50-51, 2 illus., Jan.-Feb. 1960.

Variation in the meanings of terms applicable to the migmatitic and associated rocks of Scandinavia could result in disagreements or misunderstanding among geologists attending the excursions of the 21st International Geological Congress. Geologists of Denmark, Finland, Norway, and Sweden were questioned on their understanding of terms. Clarifying definitions or pertinent comments are given for the following words: agmatite, anatexis, arterite, banded gneiss, basic front, composite gneiss, dike, ectectite, gneiss, granite, granitization, igneous, magma, metamorphic rock, metablastesis, migmatite, nebulite, palingenesis, rheomorphism, supracrustal, syntexis, veined gneiss, and venite.--M. Russell.

2-691. Williams, Paul L. A STAINED SLICE METHOD FOR RAPID DETERMINATION OF PHENOCRYST COMPOSITION OF VOLCANIC ROCKS: Am. Jour. Sci., v. 258, no. 2, p. 148-152, fold. graph, Feb. 1960, 5 refs.

In recent stratigraphic studies of Tertiary ignimbrites in the Great Basin, correlation of units by distinctive lithologic features is independently verified by quantitative study of phenocrysts. The relative abundance of 6 mineral groups can be readily evaluated by area counts, with a binocular microscope, of etched and stained rock slices. The method obtains results rapidly and with sufficient accuracy to confirm field correlations, as is demonstrated by phenocryst study of 4 tuffs comprising the Quichapa formation.--Auth.

2-692. Eaton, Jerry P., and Donald H. Richter. THE 1959 ERUPTION OF KILAUEA: GeoTimes, v. 4, no. 5, p. 24-27, 45, 7 illus., map, Jan.-Feb. 1960.

The 1959 eruption began at 8:08 P. M. Nov. 14, 1959 at Kilauea Iki Crater. Liquid-level tiltmeters, installed in Nov. 1957, had indicated for several months before the eruption that the ground surface was steadily inclining outward from the caldera. Earthquake swarms were recorded between Aug. 14th and 19th. The greatest fountain height was 1,900 ft. recorded on Nov. 17. At one time lava was coming from the vent at the rate of 1,400,000 cubic yards per hour. A lava temperature of 1,190°C. was recorded on Dec. 5. As fountain activity periodically ceased, lava flowed back into the vent at rates as high as 2,000,000 cubic yards per hour, giving rise to the idea that there may be lava geyser action involved.--M. Russell.

2-693. Wilson, M. E. ORIGIN OF PILLOW STRUCTURE IN EARLY PRECAMBRIAN LAVAS OF WESTERN QUEBEC: Jour. Geology, v. 68, no. 1, p. 97-102, 6 illus., Jan. 1960, 48 refs.

The major problems of pillow formation are: 1) the cause of lava globulation, 2) the slow deposition of the globules as shown by the supporting crust on underlying pillows, and 3) the presence of pillows in some lava flows and their absence in part or all of others. Because pillow lavas are so commonly interlayered with sediments and require rapid cooling conditions for their formation, most geologists now agree that they are subaqueous in origin. The lava probably breaks up into globules about in the same way that oil globulates when mingled with cold water. The delayed descent of the pillows, as pointed out by Reid and Dewey, may result partly from the buoyancy of the vesicular lava and partly from the uplift effect of escaping steam. The presence or absence of pillows may be related either to the temperature of the lava or the force with which it is extruded, or both.--Auth.

2-694. Wargo, Joseph G. MAGNETIC SUSCEPTIBILITY AND FUSION DATA FOR SOME VOLCANIC ROCKS FROM SOUTHWESTERN NEW MEXICO: Geol. Soc. America, Bull., v. 71, no. 1, p. 87-91, map, 3 graphs, table, Jan. 1960, 6 refs.

Magnetic susceptibility measurements have been made on 5 types of rhyolitic rocks from southwestern New Mexico, including pyroclastic rocks, flows, and welded tuffs. The susceptibility values range from 0 to 825 X 10^{-6} c.g.s. units. In general, rhyolitic white vitric crystal tuffs and black vitrophyre have the lowest susceptibility, whereas gray rhyolite flows, brown tuff breccias, and red welded tuffs have somewhat higher susceptibility values. A histogram combining data for all rock types studied suggests that a low susceptibility is common for these rhyolitic rocks.

Fusion studies made on the same rhyolitic rocks substantiate data derived by other workers and add to the information on the relationship between refractive index and SiO_2 content of these rocks. In general, the refractive index of the fused rock increases as the SiO_2 content decreases. The arc-welder technique described here appears to hold promise in the preparation of glass beads for such studies.--Auth. summ.

2-695. Fisher, Richard V. CRITERIA FOR RECOGNITION OF LAHARIC BRECCIAS, SOUTHERN CASCADE MOUNTAINS, WASHINGTON: Geol. Soc. America, Bull., v. 71, no. 2, p. 127-132, map, Feb. 1960, 14 refs.

Comparison of properties of laharic (volcanic mudflow) and pyroclastic breccias leads to the conclusion that 2 described volcanic breccias near Mt. Rainier, Washington, originated as lahars. The 2 volcanic-breccia deposits are typical of many breccias within a thick andesitic series (Eocene-Oligocene), suggesting that rapid denudation of nearby volcanoes was an important process in the accumulation of the lower Tertiary andesitic material within the southern Cascade Mountains of Washington.--Auth.

2-696. Davis, Briant L. PETROLOGY AND PETROGRAPHY OF THE IGNEOUS ROCKS OF THE STANSBURY MOUNTAINS, TOOELE COUNTY, UTAH: Brigham Young Univ., Dept. Geology, Brigham Young Univ. Research Studies, Geology Ser., v. 6, no. 2, 56 p., 19 illus., 3 maps (2 col.), 2 charts, sec., graphs, table, 1959, 13 refs.

The igneous rocks of the Stansbury Mountains consist of several hypabyssal intrusions of inter-

mediate and basic composition and 4 patches of extrusives.

Two sills, 1 sole injection, and 2 plugs represent an andesitic to trachyandesitic phase of intrusion, and 3 or 4 diabase dikes appear to be volcanic fissures. Minor rock types include augite andesite, syenogabbro, and olivine and augite calci-phonolite.

The first stage of volcanic extrusion, probably contemporaneous with intrusion, effused a series of andesite and hornblende andesite flows, tuffs, and tuffaceous volcanic breccias, and very minor amounts of basalt. Two major areas of these effusives, one each on the eastern and western flanks of the range, appear to have been once continuous. Slightly later extrusive activity poured forth calcic phonolites and soda-basalts from fissures farther to the N. On the W. flank the series measures 905 ft. thick; on the E. flank near South Willow Canyon the total section is 1,630 ft. thick.

Some low-temperature hydrothermal alteration exists in the area although no contact metasomatic zones have been recognized.

Igneous activity is dated as Eocene to Oligocene and appears to have had the following history: 1) intrusion of stock-sized pluton with projecting cupolas, dikes, and sills of trachyandesite or andesite, 2) extrusion of intermediate composition flows contemporary with stage 1, 3) extrusion of near-basic to locally undersaturated flows, and 4) normal faulting, tilting, and erosion of the flows to their present condition.--Auth.

2-697. Stewart, Duncan. **PETROGRAPHY OF SOME ERRATICS FROM CAPE ROYDS, ROSS ISLAND, ANTARCTICA:** Am. Mineralogist, v. 44, no. 11/12, p. 1159-1168, table, Nov.-Dec. 1959, 26 refs.

A petrographical study is made of a suite of rocks collected by the British Antarctic Expedition, 1907-1909, from Cape Royds, Ross Island, Antarctica [approx. 77°33'S. 166°07'E.]. Of the 169 thin sections examined, 163 are of erratics. The igneous specimens constitute approximately 80% of the collection, and may be described as typical E. Antarctica rocks. --Auth.

2-698. Leake, Bernard E., and Geoffrey Skirrow. **THE PELITIC HORNFELSES OF THE CASHEL-LOUGH WHEELAUN INTRUSION, COUNTY GALWAY, EIRE:** Jour. Geology, v. 68, no. 1, p. 23-40, 3 illus., 2 maps, 2 diags., 2 graphs, 7 tables, Jan. 1960, 37 refs.

The pelitic envelope of a basic and ultrabasic intrusion, together with the pelitic xenoliths, have been studied by field and microscopic examination, and 14 chemical analyses of the hornfelsed pelites are given. Eighteen chemical analyses of unhornfelsed pelites from the region are available for comparison. There was every gradation from biotite-acid andesine-quartz-fibrolite-garnet "regional" schist through cordierite-prismatic sillimanite-labradorite-magnetite-biotite hornfels to spinel-magnetite-cordierite $\pm$ corundum + orthopyroxene hornfels as desilication and dealkalization occurred. The SiO_2 content, 46.2%, and $Na_2O + K_2O$ content, 6.2%, in the average unhornfelsed nearby pelite fell in the xenoliths to less than 10% SiO_2 and less than 0.25% alkali, while the $FeO + Fe_2O_3$, 12.0%, and MgO, 3.4%, rose to over 40% and 9%, respectively. It is suggested that the composition of the material removed from the xenoliths to the ultrabasic magma had a composition resembling, but not identical with, that of Daly's average subalkaline granite, which result supports Bowen's theory of the interaction of basic magma and pelite.--Auth.

2-699. Engel, Albert E.J., and Celeste G. Engel. **PROGRESSIVE METAMORPHISM AND GRANITIZATION OF THE MAJOR PARAGNEISS, NORTHWEST ADIRONDACK MOUNTAINS, NEW YORK. PART II. MINERALOGY.** With Analyses of Trace Elements by A.A. Chodos and Elisabeth Godijn: Geol. Soc. America, Bull., v. 71, no. 1, p. 1-57, 4 illus. on 2 pls., 2 maps (1 fold.), diags., graphs, 33 tables, Jan. 1960, 73 refs.

Changes in the kinds and properties of minerals in the Adirondack paragneiss are related to its progressive metamorphism. The least altered gneiss at Emeryville, New York, consists of quartz, biotite, and oligoclase, with small amounts of muscovite and microcline. This assemblage formed at about 500° C. under a lithostatic load of about 5 mi. As the least altered gneiss is traced northeastward into what was a deeper, hotter environment of metamorphism, the biotite and muscovite react to produce garnet; K_2O, SiO_2, and water are expelled. At Colton, New York, 35 mi. NE. of Emeryville, temperatures of metamorphism probably reached 600° C. There, the least altered gneiss consists of quartz, calcic oligoclase, biotite, garnet, and accessory K feldspar. Migmatitic and granitized paragneiss throughout the region is enriched in K feldspar and depleted in biotite, garnet, and plagioclase.

The microcline in least altered gneiss at Emeryville occupies 1-5% of the rock. It is distinctly perthitic and contains up to 2 weight % Na_2O, 0.2 to 0.3% BaO, and from 300 to 2,600 p.p.m. Sr. With increasing grade of metamorphism gridiron twinning disappears (orthoclase appears?), and Na_2O content increases to 2.4%.

The K feldspar in the migmatite and granitized gneiss throughout the Emeryville-Colton region is almost wholly a perthitic microcline, with some abrupt and local variations in amounts of Na, Ba, and Sr. These variations in alkalis occur within individual bodies of granitic gneiss, and between microcline in these bodies and the microcline porphyroblasts in the enveloping paragneiss.

Plagioclase in the least altered gneiss at Emeryville averages Ab 73, forms about 40% by volume of the rock and shows a separation of $2\theta(1\bar{3}1)$ and 2θ (131) of 1.61. Only 5% of the plagioclase is visibly twinned (albite and pericline types). Most grains are sericitized. Zoning is very rare. With increasing grade of metamorphism plagioclase in the least altered gneiss becomes more abundant, coarser grained, and profusely twinned (large albite twinning). At Colton, plagioclase forms half the rock and is Ab 67 with $2\theta(1\bar{3}1)$ - $2\theta(131)$ of 1.71.

Plagioclase in migmatite and granitized gneiss decreases in volume and Ab content as K feldspar content of these rocks increases. The average granitic gneiss at Emeryville contains about 30% plagioclase of Ab 86.

A greenish-brown, Al-rich biotite constitutes 18% of the least altered gneiss at Emeryville. With progressive metamorphism biotite decreases in volume, in size of unit cell, and in its content of Fe_2O_3, FeO, OH, Sc, and Mn. Grain size increases, as do amounts of TiO_2, MgO, Ba, Cr, F, V, and probably in Ca. Color changes to deep reddish brown as a function of the increasing ratio of TiO_2:FeO. N_z and density undergo small, less consistent changes.

The 1M polymorphs predominate, but 2M forms are not uncommon. There is no correlation of polymorphic type with grade of metamorphism. Granitization of gneiss results in the decomposition of biotite, which forms less than 10% by volume of the average granitic gneiss. Biotite of the incipiently granitized gneiss is very similar in composition to that in associated least altered gneiss.

At Emeryville garnet is confined to pegmatites and migmatitic gneiss, but from Edwards northeastward it occurs throughout the least altered gneiss as a product of regional metamorphism. The garnets associated with pegmatite near Emeryville are spessartitic almandites with 6% MnO, 4% MgO, and 2% CaO. The first garnets to appear throughout least altered gneiss (at Edwards) contain less than 2% MnO and about 6% MgO. As the grade of metamorphism increases the garnets increase in abundance and in percent MgO, Cr, Ti, V, and Zn. Complementary decreases occur in dimensions of the unit cell, in index of refraction, density, Fe_2O_3, FeO, MnO, Ba, Sc, Y, and Yb.

In the selective distribution of mafic elements in the paragneiss, biotite accumulated more Mg, Ba, Co, Cr, Cu, Ni, Ti, and V than did garnet. Garnet is enriched in Mn, Fe, Ca, Sc, Y, and Yb. With increasing grade of metamorphism the ratio Fe^{++}+ Mn:Mg in garnet decreases from 8 to 5, and in biotite from 2.8 to 1.7 Fe^{+++}:Fe^{++} decreases in both biotite and garnet.

SiO_2: Al_2O_3 decreases in both total rock and in plagioclase with increasing grade of metamorphism of least altered gneiss. K_2O is concentrated in biotites and K feldspar, and Na in plagioclase. With progressive metamorphism K_2O:Na_2O decreases in K feldspar and total rock.

The pronounced and systematic variations in concentrations and ratios of elements in minerals and total rock between Emeryville and Colton are marked by only one classical isograd. This is the reaction of quartz, biotite, magnetite, and muscovite to produce garnet. For this region, and perhaps many others, the scope and patterns of progressive metamorphism are shown in much greater detail by changes of ratios of elements and oxides in minerals. The ratio of 2 easily determined oxides that have opposing trends in concentration is especially definitive. TiO_2:MnO in biotites changes from 16 to 520 between Emeryville and Colton. TiO_2:MnO in garnets changes from .003 at Emeryville to .06 at Colton. Ratios of Fe:Mg, Mn:Mg, or Fe^{++}+ Mn:Mg in both minerals are even more informative but also more difficult to obtain accurately.

The mineral assemblages in the paragneiss at Emeryville are complemented by diopside in adjoining dolomites, sillimanite in nearby pelitic schists, and hornblende-andesine in amphibolite interlayers. At Colton, diopside persists in the dolomitic marble, whereas in the amphibolite ortho- and clinopyroxenes have formed at the expense of about half the hornblende. These relationships indicate the transition from upper amphibolite to lower granulite facies and are accompanied by marked dehydration, decarbonization, and a basification of the total rock.--Auth.

10. SEDIMENTARY PETROLOGY

See also: Geochemistry 2-664; Mineralogy 2-685.

2-700. Fessenden, Franklin W. REMOVAL OF HEAVY LIQUID SEPARATES FROM GLASS CENTRIFUGE TUBES: Jour. Sed. Petrology, v. 29, no. 4, p. 621, Dec. 1959.

The lower portion of a glass centrifuge tube containing bromoform and heavy minerals is frozen in dry ice. The liquid bromoform and light minerals in the upper part of the tube are poured off. Bromoform in the bottom of the tube is allowed to melt, and the heavy minerals are collected.--D. Carroll.

2-701. Kornicker, Louis S. ANALYSIS OF FACTORS AFFECTING QUANTITATIVE ESTIMATES OF ORGANISM ABUNDANCE: Jour. Sed. Petrology, v. 29, no. 4, p. 596-601, 2 diags., graph, 3 tables, Dec. 1959, 17 refs.

Examination of the physical relationship between weight and volume sediment samples, and comparison of estimates of organism abundance obtained from equal volume and equal weight samples of recent sediment show that kinds of minerals forming the sediment have little effect on abundance distribution patterns determined by counting the number of specimens in samples of a given weight or volume, and that variation in sediment porosity probably is the major factor responsible for differences between organism counts based on equal weight samples and those based on equal volume samples.

Consideration of the diagenetic processes of compaction and cementation that affect organism abundance shows that for sediments, which have not been materially changed by processes such as intrastratal solution, replacement, and recrystallization, abundance counts from recent and ancient sediments are more comparable if clays and shales are reported on the basis of equal weight samples, and unlithified and lithified sands are reported on the basis of equal volume samples.--Auth.

2-702. Krumbein, W.C. THE "SORTING OUT" OF GEOLOGICAL VARIABLES ILLUSTRATED BY REGRESSION ANALYSIS OF FACTORS CONTROLLING BEACH FIRMNESS: Jour. Sed. Petrology, v. 29, no. 4, p. 575-587, 6 diags., 3 graphs, 7 tables, Dec. 1959, 7 refs.

Observations on beach firmness suggest that it is dependent on moisture content, average particle size, degree of sand sorting, and degree of packing of the beach sand. A method of multiple linear regression that may be extended to the nonlinear case is applied to the problem of "sorting out" empirically the relative effects of the controlling properties. The analysis involves several stages, in which the controlling factors are treated 1 at a time, 2 at a time, and so on, to allow for interrelations among the controlling factors themselves. A detailed example is presented for illustration of the method, and an appendix to the paper includes some theory as well as a summary of the IBM 650 program used in this study.

A summary of several sets of data suggests that moisture content is the dominant control of firmness, with average grain size more important than degree of sand sorting. Some limitations in present data on sand packing hinder evaluation of this factor, but it appears to be less important than moisture content. --Auth.

2-703. Imbrie, John and Arie Poldervaart. MINERAL COMPOSITIONS CALCULATED FROM

CHEMICAL ANALYSES OF SEDIMENTARY ROCKS: Jour. Sed. Petrology, v. 29, no. 4, p. 588-595, diag., chart, 6 tables, Dec. 1959, 5 refs.

A method is described for routine calculation of mineralogical compositions from chemical analyses of sedimentary rocks. Although designed for the particular mineral suites found in the Florena shale (a midcontinent Permian argillaceous unit containing calcite, dolomite, chert, and clay as major constituents), it can be adapted with slight modification for use with a wide variety of sedimentary rock types. After restating the bulk analysis in terms of molecular ratios, TiO_2, Na_2O, P_2O_5, SO_3, and S are disposed of as rutile, albite, apatite, gypsum, and pyrite. Next, all of the CaO and CO_2 and as much MgO as is required, are used to form calcite and dolomite. The balance of the MgO and all of the K_2O are then used to form illite and either sericite or chlorite, depending on the relative amounts of MgO and K_2O. Residual Fe_2O_3 and Al_2O_3 are computed as montmorillonite and residual SiO_2 is regarded as chert. Results of computation compare well with X-ray and insoluble residue data and the method is judged to provide an estimate of the proportions of clay, dolomite, calcite, and chert accurate to within 5%.--Auth.

2-704. Wright, Michael D. THE FORMATION OF CROSS-BEDDING BY A MEANDERING OR BRAIDED STREAM: Jour. Sed. Petrology, v. 29, no. 4, p. 610-615, diag., 3 graphs, table, Dec. 1959, 24 refs.

It is suggested that much cross-bedding may be formed by a current flowing at right angles to the dip of the foreset laminae of the cross-bedded unit. The laminae thus represent successive positions of the depositing bank of a meandering stream. A similar origin has already been proposed for cross-bedding formed by migrating beach-gullies. Fabric analyses of cross-bedded gravel show that some units have apparently originated in this way, and published investigations of cross-bedding dip directions often show patterns that are consistent with a meander-bank origin. Much more detailed work is required before any definite pronouncement as to the extent of occurrence of this type of cross-bedding can be made.--Auth.

2-705. Kemp, Augusta Hasslock. PISOLITES FORMED FROM THE OILFIELD WATER OF THE LULING FIELD, CALDWELL COUNTY, TEXAS: Jour. Sed. Petrology, v. 29, no. 4, p. 616-618, 3 illus., Dec. 1959, 7 refs.

Pisolites were being formed in 1936 during aeration of the water from the oil wells of the Luling Field, Caldwell County, Texas. The field is a faulted monocline. Production is from the Edwards (Comanchean Cretaceous). In the wells, the Edwards is porous and rotten with oil in its upper portion and water in its lower. The oil and water were produced together and separated in settling tanks. The water was hot, saline, carbonated, and saturated with hydrogen sulfide. This poisonous gas had to be removed before the water was discharged into stream floodwaters. It was removed by aeration. The well water was lead through pipes several inches in diameter to the top of wooden towers some 12 ft. high where it was discharged. Pisolites formed in the violently agitated pools on the floor below.

The pisolites ranged from 3 mm. to 50 mm. in diameter, and their shapes ranged from spherical to ovoid to irregular. Their centers were irregular and usually surrounded by many thin concentric crystalline layers of calcium carbonate, probably aragonite. A few years after 1936 the method of aeration was changed.--Auth.

2-706. Deffeyes, Kenneth S. ZEOLITES IN SEDIMENTARY ROCKS: Jour. Sed. Petrology, v. 29, no. 4, p. 602-609, 2 figs. incl. diag., table, Dec. 1959, 61 refs.

Zeolite minerals, especially analcime and clinoptilolite, are known to occur widely in sedimentary rocks both as nearly monomineralic beds and as accessory minerals. Because of the extremely fine grain size of the zeolite rocks, identifications are made most readily with X-ray diffraction techniques. A survey of the known occurrences of sedimentary zeolites shows that most, if not all, of these minerals were formed during diagenesis by the alteration of volcanic material. Rhyolite glass from vitric ash falls may be altered during diagenesis to clay minerals, zeolites, or authigenic feldspars; the mineralogy of the diagenetic products is a promising indicator of post-depositional chemical environments.--Auth.

2-707. Walker, Theodore R. CARBONATE REPLACEMENT OF DETRITAL CRYSTALLINE SILICATE MINERALS AS A SOURCE OF AUTHIGENIC SILICA IN SEDIMENTARY ROCKS: Geol. Soc. America, Bull., v. 71, no. 2, p. 145-151, 11 illus. on 2 pls., 2 graphs, Feb. 1960, 12 refs.

Petrographic studies show that carbonate replacement of detrital crystalline silicate minerals is an important and widespread process in sedimentary rocks. Investigations of 3 different rock suites indicate that authigenic siliceous features commonly occur in or near strata that contain partially to completely replaced silicate grains. This association implies a genetic relationship and suggest that silica released by carbonate replacement may be an important source of authigenic silica in some sedimentary rocks.

Such replacement is probably more common in sedimentary rocks than has been suspected because completely replaced grains commonly leave no evidence of their original presence in the sediment, or the replaced grains are preserved as carbonate pseudomorphs that can be mistaken for grains of clastic carbonate. Even in occurrences containing relicts of incompletely replaced silicate grains it generally is not possible to determine to what extent replacement has taken place.

The mechanism of solution, migration, and reprecipitation of silica is uncertain. Earlier writers have suggested that carbonate replacement of opal and subsequent reprecipitation of the released silica occurs in response to pH variations. If so, the replacement and reprecipitation of silica from crystalline silicates might be similarly explained. Recent data, however, cast doubt on this theory.--Auth.

2-708. McEwen, Michael C., Franklin W. Fessenden, and John J. W. Rogers. TEXTURE AND COMPOSITION OF SOME WEATHERED GRANITES AND SLIGHTLY TRANSPORTED ARKOSIC SANDS: Jour. Sed. Petrology, v. 29, no. 4, p. 477-492, 19 diags., 9 tables, Dec. 1959, 10 refs.

Samples of thoroughly disintegrated granite from a granitic knob (Sandstone Mountain) in the Llano area

of central Texas and from Flagstaff Mountain, Colorado, exhibit bulk sample size distributions which follow Rosin's law of crushing. This same distribution is also found in samples which have traveled several hundred yards down a small intermittent stream draining Sandstone Mountain. Less completely disintegrated granite samples from Bear Mountain, Texas, and Flagstaff Mountain depart from Rosin's law in showing a deficiency in the finer sizes. Hornblende grains weathered out of the granite at Sandstone Mountain without fracturing and zircon grains in weathered granite at Flagstaff Mountain exhibit the lognormal distribution which they probably had in the fresh granites.

Mineralogy and grain size are closely correlatable in the disintegrated granites from Texas. The percentage of quartz and rock fragments increases with increasing grain size whereas the percentage of the feldspars and heavy minerals decreases. The tendency of quartz and rock fragments to be more spherical than feldspar causes sphericity to increase with grain size. The decrease of sphericity with decreasing grain size is shown both in the samples from the Llano area and from Flagstaff Mountain.--Auth.

2-709. Swann, David H., Robert W. Fisher, and Mathias J. Walters. VISUAL ESTIMATES OF GRAIN SIZE DISTRIBUTION IN SOME CHESTER SANDSTONES: Illinois State Geol. Survey, Circ. 280, 43 p., 10 maps, 6 diags., 23 graphs, log, 4 tables, 1959, 28 refs.

This investigation was undertaken to develop a rapid semiquantitative method for obtaining large amounts of reasonably accurate data on the distribution and size of grains in consolidated sandy rocks.

Grain size distribution was estimated by measuring, under a stereoscopic microscope fitted with an eyepiece micrometer, grains judged visually to represent the maximum size and the fifth, sixteenth, fiftieth, eighty-fourth, and ninety-fifth percentiles.

Although less accurate than mechanical analyses, the visual method proved as accurate as the sample-to-sample variability of most sediments warrants. For routine examination of well samples, estimation of only the maximum and median grain sizes provided 2 significant size measures plus a measure of sorting and could be completed in 2 minutes. The phi scale was used to record the estimates.

Portions of the method were applied in a study of sandstones of Chester (Mississippian) age in southern Illinois. Grain size in the Tar Springs sandstone correlates with local variation in sand-shale ratio. The relation apparently holds for other sandstones of Chester age. Grain size distribution in the Aux Vases sandstone could support any of 3 possible origins of the formation: 1) from the Ozarks to the W.; 2) the lower part from the Ozarks and the upper from the Canadian Shield to the N.; or 3) all from the Shield. In the last case the lower coarser beds in the W. correlate with sandy beds to the E. that have been placed in the underlying Ste. Genevieve limestone. Stratigraphic, mineralogic, and cross-bedding evidence from other studies favor the third interpretation.--Auth.

2-710. Parham, Walter E. HEAVY MINERALS IN THE UNDERCLAY OF THE ILLINOIS NO. 2 COAL: Illinois State Acad. Sci., Trans., v. 52, no. 1/2, p. 13-19, 7 illus., map, 1959, 6 refs.

A petrographic study was made of 87 samples of the underclay of the Illinois No. 2 coal that were obtained from outcrops and diamond drill cores from 68 localities throughout the eastern interior basin. The study revealed a stable mineral assemblage of muscovite, tourmaline, zircon, rutile, ilmenite, and leucoxene that suggests that the material of which the underclay is composed has undergone many cycles of transportation and deposition.

Pyrite found in the clay is authigenic and is common to all of the samples. It is more abundant in the areas where the underclay has a small average grain size.

That some of the tourmaline may also have formed authigenically is indicated by the presence of euhedral crystals with double terminations that show no signs of wear. Optical properties of these euhedral crystals suggest a chemical composition different from that of the rounded and fragmental tourmaline present. An alternate hypothesis, that they might have been transported without apparent wear because of their extremely small size and hardness, also is tenable.--Auth.

2-711. Arneman, Harold F., and H.E. Wright, Jr. PETROGRAPHY OF SOME MINNESOTA TILLS: Jour. Sed. Petrology, v. 29, no. 4, p. 540-554, 2 maps, 3 diags., 9 tables, Dec. 1959, 17 refs.

Wisconsin tills in Minnesota may be assigned to different ice lobes depending primarily upon the color, texture, stone content, and other petrographic characteristics. These petrographic features have their origin chiefly in distinctive types of bedrock in Minnesota and adjacent areas. The Precambrian rocks that underlie the drift over most of the state include red sandstone and slate in a belt extending SSW. from the head of Lake Superior; basalt, felsite, gabbro, anorthosite, and related rocks in the highland N. of Lake Superior; Fe formation; and various metamorphic and granitic rocks. Paleozoic carbonate rocks are found principally in southern Manitoba but also in southeastern Minnesota. Cretaceous shale occurs in the area of the Red River Valley and in southwestern Minnesota.

The configuration of the several ice lobes was determined partly by the presence of lowlands in the bedrock, notably one following the Red River-Minnesota River valleys (Des Moines lobe) and one following a lowland extension of the Lake Superior basin (Superior lobe). The central part of the state was occupied by the Wadena lobe and the Rainy lobe, and their directions of movement were probably controlled by mutual interference as well as by preexisting topography.

The Wisconsin glacial history in Minnesota was marked also by repeated advances of the several ice lobes. In the case of the Superior lobe the tills assigned to the Cary and Valders advances may be identified texturally because the Valders till was formed by the incorporation of lake clays deposited in the Lake Superior basin during the Two Creeks interstadial just preceding, where the Cary Superior till is sandy. A Mankato Superior till, identified on morphologic grounds, appears to have an intermediate (silty) texture.

Of the 2 tills of western source, the Wadena is the more sandy, probably because the Des Moines till passed over Cretaceous shale. The tills of the Rainy lobe and its 2 sublobes (Pierz and Brainerd) are all sandy and are stonier than the tills of the other lobes.

Stone counts are perhaps the most diagnostic petrographic characteristic of Minnesota tills. They

are easily made and generally point to the correct assignment. Difficulties occur where tills contaminate one another in contact zones. Color distinctions , as measured by the Munsell color chart or in the laboratory by the Clark-Maxwell method, are also generally distinct.

Heavy-mineral analyses and clay-mineral analyses are of limited use in differentiating tills. They are time-consuming and not particularly diagnostic.--Auth.

2-712. Hershey, Robert E. PARAGENESIS OF EOCENE AND CRETACEOUS SANDS OF WEST TENNESSEE: Jour. Sed. Petrology, v. 29, no. 4, p. 619-621, 6 illus., Dec. 1959.

Sand grains are described from 10 samples collected in the Mississippi embayment section of W. Tennessee representing about 150 ft. of the McNairy sand (Cretaceous) and sands from the Claiborne and Wilcox(?) groups (Eocene). Mineralogical criteria for recognizing 3 complete cycles of erosion and deposition are given.--D. Carroll.

2-713. Tanner, William F. NEAR-SHORE STUDIES IN SEDIMENTOLOGY AND MORPHOLOGY ALONG THE FLORIDA PANHANDLE COAST: Jour. Sed. Petrology, v. 29, no. 4, p. 564-574, 3 maps, chart, profile, graph, Dec. 1959, 25 refs.

For the years 1955-1958, a team of geologists from Florida State University investigated the sediments along both sides of the shoreline of part of the coast of the Florida panhandle. These studies have extended as far as 10 mi. seaward, where diving techniques were employed, and about an equal distance landward. The bulk of the data so obtained has been concerned with approximate chemical composition (quartz, carbonate, clay), grain size, roundness, heavy mineral content, microfaunal assemblage, ripple marks and related features, and variability of the shallow sea bottom. In the study area, sorting is excellent, quartz is dominant, the grain size increases from the shoreline toward the open gulf, heavy minerals are rare, ripple marks deteriorate more rapidly than had been expected, ripple marks generally trend parallel with the shore, and mild changes in bottom topography are important in the control of sedimentation. Although living organisms having hard parts are numerous, shell fragments are rare in much of the area, and a lithified sandstone might well be essentially nonfossiliferous.--Auth.

2-714. Vause, James E. UNDERWATER GEOLOGY AND ANALYSIS OF RECENT SEDIMENTS OFF THE NORTHWEST FLORIDA COAST: Jour. Sed. Petrology, v. 29, no. 4, p. 555-563, 5 maps, 5 diags., table, Dec. 1959, 9 refs.

Diving geologists conducted a survey of part of the shallow continental shelf off the W. coast of Florida. Sedimentary analysis of samples collected from the Gulf bottom show the sediments to become more coarse and more poorly sorted outward from shore. Ripple marks were found to be predominantly wave formed and to roughly parallel the shore. Clypeaster sp. were observed to be destroying the ripple marks in many places. Bedrock which crops out in the area is thought to be the St. Marks facies of the Tampa stage.--Auth.

2-715. Towe, Kenneth M. PETROLOGY AND SOURCE OF SEDIMENTS IN THE NARRAGANSETT BASIN OF RHODE ISLAND AND MASSACHUSETTS: Jour. Sed. Petrology, v. 29, no. 4, p. 503-512, map, 2 graphs, table, Dec. 1959, 23 refs.

The Narragansett basin, a Pennsylvanian epieugeosyncline, contains 5 lithologic units, the most extensive of which is the Rhode Island formation. The rocks of the basin are predominantly sandstone and conglomerate and all are of continental origin. Lithic graywacke is the common sandstone type and the poorly sorted conglomerates are made up mostly of quartzite roundstones. Cross-stratification and the orientation of plant fossils indicate that the major source area for the sediments of the Narragansett basin lay to the NE.--Auth

2-716. Zen, E-An. MINERALOGY AND PETROGRAPHY OF MARINE BOTTOM SEDIMENT SAMPLES OFF THE COAST OF PERU AND CHILE: Jour. Sed. Petrology, v. 29, no. 4, p. 513-539, map, 5 tables, Dec. 1959, 30 refs.

The mineralogy and petrography of 40 cores of marine bottom sediments from the Peru-Chile trench area were studied by X-ray and microscopic techniques. Samples from each core were collected at intervals of 10 cm., or more frequently where visible lithologic variations occur. The - 1.3μfractions of many of these samples were also studied and the clay minerals identified by means of treatment with ethylene glycol and by heating to 200°C and to 450°C.

The most common minerals in the cores are quartz, plagioclase, calcite, and the clay minerals kaolinite, chlorite, illite, and a mixed-layer clay, predominantly montmorillonite. Halite and gypsum are important in many cores as results of dehydration of the cores. Volcanic glass, in various stages of devitrification, is extremely common in nearly all the cores; some samples are sufficiently abundant in glass to be called ash beds.

Among the less common minerals are aragonite, dolomite, rhodochrosite, potassic feldspar, glauconite, biotite, phillipsite, pyroxene, and amphibole. Chemically precipitated dolomite is found in 1 core at a water depth of 4,600 m. Besides dolomite, minerals which are at least partly authigenic are quartz, calcite, rhodochrosite, phillipsite, glauconite, and kaolinite. The observed mineral associations are given in a table.

The gross lithology of the cores includes sand, silt, mud, black mud, and calcareous and siliceous ooze. While large lithological variations exist between adjacent cores, within each core the lithology tends to be fairly uniform over the entire length.

The methods of identification of the 7-14 Å clay minerals are in an unsatisfactory state. The Bradley criteria are applicable to fine-grained, poorly crystalline chlorite, of relatively lower thermal stability than the well-crystallized chlorite to which the Brindley criteria apply. The very identification of a chlorite in a mineral mixture would thus be predicated on assumptions regarding the detailed nature of the material. The 2 sets of criteria, however, are not altogether contradictory; by a suitable combination it is possible in many cases not only to identify the chlorite but also to estimate its crystallinity. Most of the chlorites from the Peru-Chile trench area satisfy the Bradley criteria.

Samples from the seaward side of the Peru-Chile trench are uniformly fine mud. Samples from within the trench are largely fine mud but include thin beds of silty to sandy material. Samples from the land-

ward side of the trench are heterogeneous in size as well as in mineralogical and chemical compositions. Although on the whole the nearshore samples tend to be most coarse-grained, there is no simple correlation between grain size and distance from the coast, nor between grain size and bottom topography. Sediment transport appears to be due largely to bottom currents, the existence of which is independently established by the discovery of graded bedding and cross-bedding in a number of the cores.--Auth.

11. GEOHYDROLOGY

See also: Areal and Regional Geology 2-541; Engineering Geology 2-768.

2-717. Walton, William C., and J.W. Stewart. AQUIFER TESTS IN THE SNAKE RIVER BASALT: Am. Soc. Civil Engineers, Irrigation & Drainage Div., Jour., v. 85, no. IR3, pt. 1, p. 49-69, 9 figs. incl. graphs, logs, 4 tables, Sept. 1959, 4 refs.

The results of 11 aquifer tests and specific capacity data for 238 production wells indicate that the coefficient of transmissibility of the Snake River basalt ranges from 1 X 10^5 g.p.d. per ft. to 1.8 X 10^7 g.p.d. per ft. and averages about 4 X 10^6 g.p.d. per ft. The coefficient of transmissibility of the entire thickness of the Snake River basalt probably greatly exceeds the values determined from test data because the wells for which data are available partially penetrate the aquifer. The coefficients of storage computed from test data are all in the water-table order of magnitude and range between 0.02 and 0.06. For the Snake River plain, the average yield of the basalt to a 16-in. well during a well-acceptance test 8 hours in duration is about 2,100 g.p.m. per ft. The aquifer ranks as one of the most productive in the United States. The average depth of well below land surface is 290 ft. and the average penetration below the regional water table is 100 ft.--Auth.

2-718. Carter, Ralf C., W.J. Kaufman, G.T. Orlob, and David K. Todd. HELIUM AS A GROUND-WATER TRACER: Jour. Geophys. Research, v. 64, no. 12, p. 2433-2439, diag., 6 graphs, table, Dec. 1959, 10 refs.

Laboratory and field experiments were conducted with He as a ground-water tracer. Techniques were developed for the addition and extraction of He from water. A mass spectrometer and a pressure-volume apparatus were used for He measurements at concentrations in water ranging from 1.5 to 5.5 X 10^{-4} milligrams per liter. In the field investigation, flow was traced through a confined aquifer for a distance of 188 ft. Both laboratory and field experiments showed that He traveled at a slightly lower velocity than chloride. The advantages of He as a ground-water tracer are its safety, low cost, relative ease of analysis, low concentrations required, and chemical inertness. The disadvantages include the relatively large errors in analysis, difficulties of maintaining a constant recharge rate, time required to develop equilibrium conditions in unconfined aquifers, and possible loss to the atmosphere in unconfined aquifers.--Auth.

2-719. Powell, William J., and P.E. LaMoreaux. GROUND-WATER INVESTIGATIONS IN ALABAMA, WITH A SELECTED BIBLIOGRAPHY: Alabama, Geol. Survey, Inf. Ser. 15, [4] p., 2 maps, 1959, 32 refs.

Of the 320 incorporated municipalities in Alabama, 207 use ground water for public supply. Ground-water investigations were begun in 1898 by the U.S. Geological Survey in cooperation with the Geological Survey of Alabama. They were discontinued in 1933 and resumed in 1940. The program is as follows: 1) areal reconnaissance of the 4 principal geologic areas of the state; 2) a series of county-by-county investigations to supply the needs for detailed ground-water data for the state; 3) detailed studies made in response to critical water shortages or depletion of ground-water supplies in local areas; 4) an observation-well program to show water-level trends in principal water-bearing formations and to forewarn of depletion of sources of supply. The status of the projects and the availability of reports are shown on maps.--A.C. Sangree.

2-720. Henry, Charles W., Jr., and James A. Lavender. FINAL REPORT ON AN INVENTORY OF FLOWING ARTESIAN WELLS IN FLORIDA, LEADING TO THE ENFORCEMENT OF SECTIONS 373.021-373.061, FLORIDA STATUTES, 1957: Florida Geol. Survey, Inf. Circ. no. 21, 30 p., illus., 4 maps, 3 tables, 1959, 4 refs.

The report deals with subsurface water, its classification, occurrence, the Floridan aquifer, piezometric surface; major water problems; misuse of ground water; current program; conclusions and recommendations. Maps show the distribution of fresh-water aquifers, the approximate areal extent of the Floridan aquifer, piezometric surface of the Floridan aquifer, and approximate area of artesian flow.--A.C. Sangree.

2-721. Hawaii, Water Authority. WATER RESOURCES IN HAWAII: 148 p., 5 illus., 32 maps, 2 diags., 58 graphs, 9 tables, Honolulu, March 1959, approx. 70 refs.

This report has been compiled to inform legislators and the general public of the status of water resources, the problems peculiar to Hawaii, and the areas recommended for further study. General conclusions are drawn on the following topics: variety of problems, adequacy of water resources, water usage, surface-water diversion, ground-water occurrence, changing conditions, control of ground-water withdrawals, water-deficient areas, collection of hydrologic data, specific hydrologic studies, water rights, legal aspects of ground-water development, and ground-water law. The report is divided into 4 parts. Pt. 1, Water Occurrence, deals with physical features of Hawaii, the hydrologic cycle, climate, surface water, and ground water. Pt. 2, Water Utilization, covers water use in Hawaii, and conservation of water resources. Pt. 3, Water Rights, is concerned with rights to the use of water in general, rights to the use of water in Hawaii, ground-water development, ground-water management, and water-rights summary. Pt. 4, Water Development, deals with water problem areas by islands, and planning water projects. Maps, tables, and graphs are included in Appendix A; documents and references are given in Appendix B.--L. M. Dane.

Conclusions dealing with ground water are as

follows: The rainfall of the state is relatively high, averaging better than 70 in. annually. Extreme variations in distribution of rainfall, wide differences in monthly, seasonal, and annual rainfalls, recurring droughts, lack of suitable impounding reservoir sites, problems of salt water intrusion in basal ground-water supplies, and mountainous topography make development of Hawaii's water resources both difficult and costly.

Highly permeable soils and rocks permit much of the rainfall to infiltrate to ground-water supplies. The chief sources of ground water are the lenses of fresh water floating on intruded sea water which generally underlie all the islands except in shoreline zones where brackish water prevails. The high ground surface elevations found in most of the inland areas are not favorable to the economic development of a large part of this basal water. Elsewhere, water withdrawals from fresh water-salt water balanced lenses must be carefully managed to prevent deterioration in quality by salt water intrusion.

Pumping from ground-water supplies of the state is currently within safe yield limits. A critical problem of overdraft could occur in some aquifers and is foreseeable in the Pearl Harbor aquifer if additional water development facilities are constructed without compensating conservation measures. The recent formation of the Ewa District Water Users Association on Oahu, together with existing water development agreements, can be expected to provide adequate voluntary controls to prevent overdraft in the Pearl Harbor aquifer during the next few years.

Detailed hydrologic studies of water resources are distinct and apart from the state-wide collection of hydrologic data carried out on a continuing basis. One such project, the Pearl Harbor-Honolulu aquifer study by the U. S. Geological Survey, is nearing completion. The increasing need for additional supplies of water on Oahu, and the further fact that ground-water sources on this island are largely interdependent, warrant an extension of this study to include other surface and ground-water sources on Oahu in an accelerated program. Similar detailed studies of water sources elsewhere in the state should be undertaken in the future as the need arises.

Extensive development of ground water has taken place in Hawaii, either in the absence of ground-water rights law or when such law was only partially set forth by the courts. As competition in the use of water from subterranean sources increases, the matter of ground-water rights will become increasingly important as a factor in water development. Some existing water uses from certain aquifers in the state might be adversely affected if ground-water rights were adjudicated through the courts. Ground-water rights law can be based on the common law and determined by the courts or established through statutory procedures. As it is concluded that no further serious problems of overdraft in aquifers of the state will occur during the next 2 years at least, further study of ground-water rights law during the coming biennium by a representative group of legislators, water users, landowners, attorneys and hydrologists appears desirable.

A better program for preventing waste of ground water and in sealing leaking artesian wells could be accomplished if present state-wide statutes were amended to provide additional authority comparable to that prevailing in the District of Honolulu. Other conservation measures such as sealing springs, constructing ground-water recharging installations, improvements to watersheds, and flood control projects could be better accomplished through closer coordination of efforts and by more clearly assigned responsibilities for some of these undertakings. It is believed that the state could obtain more technical and financial assistance from federal agencies if greater efforts were made in this direction.--From auth. concl.

12. MINERAL DEPOSITS

See also: Areal and Regional Geology 2-535, 2-544; Geophysics 2-636, 2-637; Geochemistry 2-663, 2-667.

2-722. Lacy, W.C., ed. EDUCATIONAL REQUIREMENTS AND THE FUTURE OF THE MINERAL INDUSTRIES: Mining Engineering, v. 12, no. 1, p. 34-37, Jan. 1960.

Students and young engineers not yet established in the mineral industry face the problem: "What is the future of the mineral industries, and what type of training will best qualify the scientist or engineer for this challenging field?" This question was posed to a number of leaders in different phases of the industry. Their comments are summarized as a guide to those considering a career in the finding, extraction, or beneficiation of mineral products.--Auth.

The following discussions are included in the article:

Brant, A. A. Exploration and Geophysics, p. 34-35.
Kruger, F. C. Industrial Minerals, p. 35-36.
Weiss, Norman. Minerals Beneficiation, p. 36-37.

2-723. Goldman, Harold B. URBANIZATION AND THE MINERAL INDUSTRY: California, Div. Mines, Mineral Inf. Service, v. 12, no. 12, p. 1-5, 9 illus., Dec. 1959.

California's explosive population growth has created problems in the mineral industry. Producers of low cost commodities such as rock, sand and gravel, are being crowded out of existence by urban growth. When these natural resources are no longer readily available, raw materials are imported at additional expense.

Judicious planning is needed for wise land use and to conserve our mineral resources. The diverse uses of land for agriculture, recreation, residential and industrial development can be integrated with mining. Long range planning can help conserve our mineral deposits for future exploitation, but the cooperation of planning bodies, civic officials, mineral producers, private consultants and government agencies, is essential for a properly integrated program.

Civic leaders must apprise themselves of the mineral wealth within their jurisdiction. Careful planning and careful zoning should be used to set aside mineral lands and to set up requirements for their proper exploitation. Mineral producers must cooperate with planning and civic officials and the general public in abiding by ordinances. Good public relations must be maintained with the residents in the vicinity of a pit or quarry.

The City of Los Angeles has integrated its sand

and gravel resources in the San Fernando Valley with the over-all expansion program by creating natural resource zones.

Planning bodies can inform themselves of the potential mineral reserves by using consulting geologists, mining engineers, or state and federal agencies. The California Division of Mines in particular, is a source of information on the geology and mineral resources.--Auth.

2-724. Lydon, Philip A. OLD ARRASTRES NEAR SIERRA BUTTES: California,Div. Mines, Mineral Inf. Service, v. 12, no. 11, p. 1, 10-11, illus., Nov. 1959, 2 refs.

During the 1850's, Au miners in California ground Au-bearing quartz in small mills known as arrastres. Broken ore was placed in a circular trough with a stone bottom and ground by a heavy rock that was dragged along the trough by a mule. The Au was recovered by amalgamation. Two recently discovered arrastres are described and photographs of them presented.--Auth.

2-725. Lyon, R.J.P., and W.M. Tuddenham. QUANTITATIVE MINERALOGY AS A GUIDE IN EXPLORATION: Mining Engineering, v. 11, no. 12, p. 1233-1237, 3 illus., 5 diags., table, Dec. 1959, 8 refs.

At Kennecott's Research Center all samples received are now processed with infrared spectrophotometer, X-ray diffraction, and differential thermal analysis units on a routine basis. These semiautomatic instruments are unaffected by grain size of the minerals and greatly assist rapid quantitative determinations. When coupled with thin-section and polished-section study of the rocks, this integrated approach gives better over-all coverage, combining the areas of mineralogy in which each particular instrument is most sensitive.--Auth.

2-726. Cantwell, T., H.E. Hawkes, and N.C. Rasmussen. NUCLEAR DETECTOR FOR BERYLLIUM MINERALS: Mining Engineering, v. 11, no. 9, p. 938-940, 2 diags., 2 tables, Sept. 1959, 9 refs.

A semiquantitative method, depending on a nuclear reaction that is selective for Be, has been developed experimentally. The method of determining the Be content of crushed mineral samples has been given a preliminary test with standard laboratory equipment.--Auth.

2-727. Spinks, J.W.T. SULFUR ISOTOPES AND HYDROTHERMAL MINERAL DEPOSITS: Econ. Geology, v. 55, no. 1, p. 206, Jan.-Feb. 1960, 4 refs.

Discussion of GeoScience Abstracts 1-1467. Experiments are briefly mentioned in which surface exchange apparently causes fractionation of Sr isotopes (Sr^{89} and Sr^{90} or Sr^{85} and Sr^{90}). Parallel situations must occur in nature, e.g., when ground waters or hydrothermal solutions pass over slightly soluble salts.--J. A. Chamberlain.

2-728. Chaykovsky, V.K. A SCHEME FOR GENETIC CLASSIFICATION OF ENDOGENIC ORE-FORMING PROCESSES. Translated by Research International: Internat. Geology Rev., v. 1, no. 11, p. 37-47, 3 maps, 4 diags., table, Nov. 1959, 15 refs.

Classification of endogenic ore-forming processes is based on relations existing between mineralization products and intrusions of different composition. Occurrences of contact and near-vein metamorphism are similar. By generalizing information obtained on near-vein alteration and fissure development within intrusion fields, it is possible to conclude that granitoid magmatic source of mineralization, as it grows more basic with depth, approximates gabbro-diorite in composition. Development of ore-body groups within such a field depends upon 3 independent phenomena: fissure-aureole, mineralization, and magmatic zoning. The classification scheme for ore-forming stages associated with magma indicates close relationship between ore occurrences and granitoid magmas of particular composition, either at the surface or at depth.--Translator.

2-729. Schnellmann, G.A. SOME CONSIDERATIONS IN DETERMINING THE ORIGIN OF ORE DEPOSITS OF THE MISSISSIPPI VALLEY TYPE: Econ. Geology, v. 55, no. 1, p. 205, Jan.-Feb. 1960, 2 refs.

Discussion of GeoScience Abstracts 1-2004. Evidence is shown that suggests an igneous affiliation for ore deposits of the Mississippi type in the N. Pennine area of England. A gravimetric survey of the area has been interpreted to indicate the presence of a granitic mass at a depth of 5,000 ft. around which mineral zones are symmetrically disposed. A drill hole is required to convert this into certain evidence for igneous affiliation.--J. A. Chamberlain.

2-730. Heyl, Allen V., Jr., Allen F. Agnew, Erwin J. Lyons, and Charles H. Behre, Jr. THE GEOLOGY OF THE UPPER MISSISSIPPI VALLEY ZINC-LEAD DISTRICT. With special sections by Arthur E. Flint: U.S. Geol. Survey, Prof. Paper 309, 310 p., 24 maps and secs. (under separate cover), 101 figs. incl. illus., maps, secs., diags., graphs, 8 tables, 1959, 329 refs.

The upper Mississippi Valley district, a major source of Zn and Pb, includes 4,000 sq. mi. in Wisconsin, Illinois, and Iowa. Cu, barite, and pyrite have also been produced. The areal, structural, and economic geology of the entire district is described in detail, and the stratigraphy and geomorphology are summarized. The ore bodies are closely related to gentle folds of tectonic origin that are further accentuated by solution thinning where mineralized. The ore bodies are controlled by faults and joints of unusual pattern and lie within local halos of altered rocks. The wallrock alteration processes related to ore deposition include solution thinning of the carbonate wallrocks, silicification, dolomitization, and leaching of carbonate cement to form sanded dolomite. Ni, Co, Ag, As, Cu, and Mn occur in small quantities in the ores. The origin of the ores is still controversial as in other Mississippi Valley-type districts, but rising hydrothermal solutions of from 80°to 105°C. are favored as the most probable agent of deposition. The district is zoned with Cu central and Pb peripheral. The report includes detailed geologic maps of 6 productive areas; more than 450 mines are described, and illustrated with geologic maps.--Auth.

2-731. Donoghue, H.G., W.S. Adams, and C.E. Harpur. TILT COVE COPPER OPERATION OF THE MARITIMES MINING CORPORATION, LIMITED: Can. Mining & Metall. Bull., v. 52, no. 563, p. 150-169,

17 illus., 4 maps, 2 secs., 13 diags., tables, March 1959, 2 refs.

The paper covers all phases of the operation - geology, mining, and milling. The property is located on the eastern coast of Newfoundland at 50°N., near the northern tip of Burlington peninsula. The complexly folded and faulted early Ordovician Snook's Arm group (andesitic lavas and tuffs, siltstones, cherts, and shales) and the late Ordovician or early Devonian Cape St. John group are separated by a belt of altered ultrabasic rocks. Devonian(?) dikelike intrusions of quartz diorite porphyry are the youngest rocks on the property.

The mineralogy of the ores is simple: chiefly pyrite with chalcopyrite and small amounts of pyrrhotite, sphalerite, and locally magnetite. Wire Ag and Au-Ag alloys are present in recoverable amounts. Maucherite, niccolite, chloanthite, gersdorffite, nickeliferous arsenopyrite, and millerite made up a small deposit mined by former operators.

The roughly lenticular, plunging ore bodies occur in highly chloritized, sheared, and brecciated andesitic pillow lavas and agglomerates of the Snook's Arm group, and seemingly are spatially related to the quartz diorite porphyry. The bodies are either 1) massive sulfide deposits dominantly of fine-grained pyrite, or 2) stockworks of irregular clusters, disseminations, stringers, and veins of pyrite-chalcopyrite mineralization.--P. R. Eakins.

2-732. Vhay, John S. A PRELIMINARY REPORT ON THE COPPER-COBALT DEPOSITS OF THE QUARTZBURG DISTRICT, GRANT COUNTY, OREGON: U.S. Geol. Survey, Repts., Open-File Ser., [no. 504], 20 p., 3 maps (in pocket), [1960?], 5 refs.

The Cu- and Co-bearing veins of part of the Quartzburg district are in fracture zones trending about N. 70°E. in folded Permian (?) metavolcanic rocks on the SW. side of a quartz diorite stock. Along many of the veins fine-grained tourmaline and quartz have replaced the country rock. The primary ore minerals are chalcopyrite, glaucodot, safflorite, and cobaltite. The Cu- and Co-rich parts of the deposits appear to be in separate ore shoots. Au content is generally higher in the Co-bearing parts of the veins than in the Cu-rich parts.

The Standard mine has developed part of one vein zone. Several other vein zones that crop out may contain as much Cu as the Standard vein zone. Further bulldozing and diamond drilling on the surface, and more geologic mapping, sampling, and diamond drilling underground are suggested as means to explore for more ore deposits.--Auth.

2-733. Mair, J.A., A.D. Maynes, J.E. Patchett, and R.D. Russell. ISOTOPIC EVIDENCE ON THE ORIGIN AND AGE OF THE BLIND RIVER URANIUM DEPOSITS: Jour. Geophys. Research, v. 65, no. 1, p. 341-348, illus., 4 tables, Jan. 1960, 14 refs.

Istopic analyses of Pb extracted from a variety of minerals from Blind River, Ontario, are reported. The detrital minerals monazite and zircon both give Pb-ratio ages of 2,500 million years. The uraninite ore gives a Pb-ratio age of 1,700 m.y. Other isotopic evidence is quoted to suggest that the age of the sediment in which the U is found may also be approximately 1,700 m.y, or older. The Pb found in pyrite, pyrrhotite, sericite, and feldspar has anomalous isotopic ratios which can be explained by the hypothesis that they received additions of radiogenic Pb from the uraninites (presumed to be 1,700 m.y. old) 1,200 to 1,300 m.y. ago. In any case the age of these minerals, in the sense of time of last chemical alteration, is not greater than 1450 + 150 m.y. All our measurements can be interpreted without assuming a major period of mineralization more recent than 1,000 m.y. ago, although we are unable to rule out such a possibility from our evidence.--Auth.

2-734. MacKevett, E.M., Jr. GEOLOGY OF THE ROSS-ADAMS URANIUM-THORIUM DEPOSIT, ALASKA: Mining Engineering, v. 11, no. 9, p. 915-919, 4 illus., 4 maps, diags., 2 tables, Sept. 1959, ref.

The Ross-Adams deposit [southern Prince of Wales Island, SE. Alaska] represents an uncommon type of U-Th deposit in which uranothorite and uranoan thorianite are the chief ore minerals. The deposit, which forms a crudely fusiform ore body in alkali granite, is the source of the only U ore that has been mined in Alaska.--Auth.

See also GeoScience Abstracts 1-997.

2-735. Stockdale, Paris B., and Harry J. Klepser. THE CHATTANOOGA SHALE OF TENNESSEE AS A SOURCE OF URANIUM: U.S. Atomic Energy Comm., [Pub.], ORO-205, 223 p., 10 illus., 4 maps (2 in pocket), 8 secs., 34 tables, July 1959, 83 refs.

The area involved is primarily the eastern and northern highland rim of Tennessee. The aim of the study made was to obtain a complete geologic picture of the Chattanooga shale with especial emphasis upon physical stratigraphic relationships and associated problems; much attention was given to chemical analyses and amounts of U present. The Chattanooga shale is of Late Devonian-Early Mississippian age; in the studied area it ranges in thickness from featheredge to 38 ft., except at one locality where it is more than 180 ft. thick.

There is a marked difference in the U content of the different stratigraphic members and units of the Chattanooga shale in the eastern and northern highland rim of Tennessee and adjoining Kentucky. Likewise, irregularities occur from place to place within a given unit. Analyses show variations dependent upon the degree of weathering. The blacker portions are generally richer in U than the lighter, grayish parts. The Gassaway member of the Chattanooga shale, with a rather steady thickness ranging generally from 15 to 18 ft. in the area of study, is much richer in U than the Dowelltown member. Therefore even though the U content is extremely small, it is the more attractive source of U within the formation. County averages of different units of the Gassaway member range approximately between 0.0041 and 0.0084% U. The topmost, or E unit, is the richest; the C unit is next; and the D unit is third. The average percent of U for the Gassaway member as a whole, by counties throughout the area of study, ranges from approximately 0.0047 to nearly 0.0070. In this member there is a slight increase in U content S. of DeKalb County, and a decrease northward. Across the outcrop area of the northern highland rim, and in adjoining Kentucky, where the unit subdivisions of the Gassaway member cannot be separated, the average content by counties ranges between approximately 0.0047 and 0.0058% for the member as a whole. Of the 2 stratigraphic members of the Chattanooga shale, the Dowelltown is distinctly leaner than the Gassaway. County averages of different units of the Dowelltown member generally range between approximately 0.0011 and 0.0033% U. Where

the 2 units of this member can be separated, the bottom, blackish A unit is generally richer than the alternating gray and black B unit above. Where the gray bands are absent and the B unit cannot be separated, as in the northern highland rim, the Dowelltown member as a whole contains U ranging between approximately 0.0016 and 0.0031% average per county.

The total amount of U in the formation is estimated at from 19,500,000 tons to 39,000,000 tons; no evaluation of the amount which might feasibly be recovered is made. The immediate source of U was the sea water from which precipitation took place under reducing conditions. The oil content of the Chattanooga shale ranges from a trace to 15.7 gallons per ton; little or no relation between oil content and U content could be found.--M. Russell.

2-736. Patterson, Sam H. PROGRESS REPORT ON THE INVESTIGATIONS OF BAUXITE DEPOSITS IN THE EASTERN PART OF KAUAI, HAWAII: U.S. Geol. Survey, Repts., Open-File Ser., [no. 503], 12 p., illus., 3 maps, [1960?], 2 refs.

Investigations of bauxite deposits on Kauai, Hawaii, are to consist of 2 phases, each of 2 years duration. The first phase covers field work primarily, the second, laboratory study and reporting. Compared to the bauxite deposits on Kauai, the deposits on the island of Hawaii are much larger but lower in grade, the deposit on Maui is higher grade but not nearly so large. Thus when both size and grade factors are considered the Kauai deposits are clearly the most favorable for large-scale development. By Dec. 1959, 107 auger holes had been drilled, 650 samples shipped to the laboratories, and 225 samples examined by portable differential thermal analysis technique.--M. Russell.

2-737. Ver Planck, William E. SODA ASH INDUSTRY OF OWENS LAKE, 1887-1959: California, Div. Mines, Mineral Inf. Service, v. 12, no. 10, p. 1-6, illus., Oct. 1959, 15 refs.

The commercial production of soda ash from Owens Lake was made possible by the completion of the Carson & Colorado Railroad into Owens Valley in 1883. In 1887 the Inyo Development Company, using a solar evaporation process, began producing soda ash 95% pure. Shortly before World War I the Natural Soda Products Company and the California Alkali Company built bicarbonate process plants in which lake water, concentrated by solar evaporation, was carbonated with lime kiln gas. The product was discolored soda ash 97-99% pure. The desiccation of Owens Lake, which was complete by 1923, made solar evaporation inapplicable and the bicarbonate process difficult to operate. The Inyo Development Company went out of business in 1918 and the Inyo Chemical Company, successor to the California Alkali Company, in 1932. In 1929 the Pacific Alkali Company completed a sesquicarbonate process plant in which strong brine was carbonated with flue gas to produce white soda ash and solium sesquicarbonate. During and shortly after World War II the Natural Soda Products Company and the Permanente Metals Corporation also operated sesquicarbonate process plants. Since 1952, the only producer of soda ash on Owens Lake has been the Columbia-Southern Chemical Corporation, which bought the Pacific Alkali Company plant in 1944 and rebuilt it in 1958. --Auth.

2-738. White, W. Arthur. CHEMICAL AND SPECTROCHEMICAL ANALYSES OF ILLINOIS CLAY MATERIALS: Illinois State Geol. Survey, Circ. 282, 55 p., 2 tables, 1959, 26 refs.

This report brings together all the published and unpublished chemical and spectrochemical analyses that are available for Illinois clay materials. Deposits analyzed include both active and abandoned pits and mines as well as some deposits that never have been worked and for which no chemical and mineralogical data have been available.

The tables of chemical composition should aid in planning the commercial development of current or new operations and in extending the use of clay materials.--Auth.

2-739. Goldman, Harold B. FRANCISCAN CHERT IN CALIFORNIA CONCRETE AGGREGATES (With a table by Ira E. Klein): California, Div. Mines, Spec. Rept. 55, 28 p. 18 illus., 8 figs., 5 tables, 1959.

Sources of concrete aggregate in the Coast Ranges have been viewed with suspicion because they contain large proportions of chert derived from the Jurassic-Cretaceous Franciscan group. The Franciscan chert has been categorized with chert from the Miocene Monterey group as being potentially chemically reactive with alkalies commonly found in portland cement. Comparisons of the geologic occurrence, petrography, chemistry, and origin of these 2 rock types reveal many differences, the most important being that the Monterey chert contains significant amounts of highly reactive opaline material, while the Franciscan chert contains less reactive chalcedonic silica.

Laboratory tests demonstrate that the Franciscan chert is moderately reactive. Mortar bar tests made with crushed Franciscan chert and high alkali cement show harmful expansions due to reactivity, when the proportion of chert exceeded 10% in the sand sizes. Aggregates containing more than 20% Franciscan chert in any gravel size or more than 10% chert in any sand size are to be considered as potentially reactive. Data on the distribution of Franciscan chert in deposits of the major Coast Ranges streams are presented to show that the proportion of chert rarely exceeds these amounts. Field examination of mass concrete structures built with sand and gravel containing varying proportions of Franciscan chert revealed no signs of alkali-aggregate reaction after 20 to 50 years.

Commercial aggregates or potential materials in streams draining terrains underlain by Franciscan rocks should not on the whole be considered suspect of alkali-aggregate reaction because of their chalcedonic chert content. Only a few deposits contain the chert in proportions believed large enough to cause harmful expansion. These can be utilized, as can other deposits containing excessive amounts of other reactive ingredients, providing the alkali content of the cement is controlled.--Auth.

2-740. Sund, J. Olaf. ORIGIN OF THE NEW BRUNSWICK GYPSUM DEPOSITS: Can. Mining & Metall. Bull., v. 52, no. 571, p. 707-712, 8 illus., map, sec., table, Nov. 1959, 12 refs.

The New Brunswick gypsum and anhydrite deposits make up part of the Windsor group in the Upper Mississippian. The present deposits were formed by surface hydration of the underlying anhydrite beds. The subhydrate, hydrate, and dihydrate stages of gypsum are formed from the anhydrite by this

hydration. The anhydrite was precipitated from sea water in embayments that were separated from the sea by a reef or baymouth bar. The anhydrite is the original form of the calcium sulfate precipitate. One gypsum deposit near Plaster Rock in northern New Brunswick was precipitated from sea water directly as gypsum, which is its present form.--Auth.

2-741. Haynes, Williams. BRIMSTONE, THE STONE THAT BURNS; THE STORY OF THE FRASCH SULPHUR INDUSTRY: 308 p., 60 illus., 2 maps, 4 secs., diag., 3 graphs, 24 tables, Princeton, New Jersey, D. Van Nostrand Co., 1959, refs.

This book is based on an earlier work entitled The Stone That Burns, published 1942. The revised edition brings the story of the sulfur industry up to date from 1942 to 1959. The early history has been condensed, material on the Sicilian industry and details of the controls and allocations of World War I have been rather drastically cut. Illustrations are included of the original Frasch operations of the Union Company. Data on world production, uses, costs, and grades are given in 24 appendix tables.--M. Russell.

2-742. Beck, L.S. MINERAL OCCURRENCES IN THE PRECAMBRIAN OF NORTHERN SASKATCHEWAN (EXCLUDING RADIOACTIVE MINERALS): Saskatchewan, Dept. Mineral Resources, Rept. no. 36, 134 p., 2 maps, 20 figs., 1959, refs.

This report presents a descriptive list of known mineral occurrences in the Precambrian of Saskatchewan, excluding radioactive minerals. The occurrences are divided into 7 major groups according to the main economic mineral present, and each group is subdivided geographically for easy reference. All the available information regarding geology, mineralization, and development work is given for each occurrence.--Auth.

2-743. Symons, Henry H., and Fenelon F. Davis. CALIFORNIA MINERAL PRODUCTION IN 1958: California, Div. Mines, Mineral Inf. Service, v. 12, no. 11, p. 1-9, Nov. 1959.

The significant events showed that 1958 was in general a year of declining mineral production. The total value of mineral production in the state was $1,503,000,000, off 9% from the $1,650,000,000 (revised) figure reported in 1957.

Despite this temporary setback, after 7 years of continuously rising values, the total value remained the third highest in the state's history, falling about midway between the corresponding figures for 1955 and 1956. The industrial mineral group actually registered a 1% increase in value compared to 1957. Some important individual commodities in both the industrial mineral and metal groups which reported an increase in production were: cement, Au, gypsum, Mn ore, Hg, sand and gravel, and talc.--F. F. Davis.

2-744. Mellen, Frederic F. MISSISSIPPI MINERAL RESOURCES: Mississippi State Geol. Survey, Bull. 86, 100 p., 45 figs., 2 pls., 10 tables, 1959, refs.

The report summarizes Mississippi's contribution to the national mineral economy, reviews the trends in production of various mineral items, discusses the geographic and geologic distribution of the various raw mineral materials and suggests opportunities for further development of these resources.

From 1915 through 1930 Mississippi ranked 47th in mineral production among the 50 reporting units in the nation. With the discovery of gas at Jackson in 1930 and oil at Tinsley in 1939, the petroleum industry has given impetus to growth in mineral economy so that Mississippi now ranks 24th in the nation, the dollar value of mineral production rising from less than $2,000,000 in 1926 to over $132,000,000 in 1956.

Industries other than oil and gas are beginning to show material growth, and local capital is increasingly used in development of new mineral-using industries. Although mineral raw materials in large quantities are imported for processing in Mississippi, and although many finished mineral products are brought into the state for distribution and sale, much, if not all of the demand for these materials and products can be satisfied by proper exploration and exploitation of local raw materials. An improvement in the degree of self-sufficiency of the state is necessary to a virile economy.

Industries whose expansions appear desirable are agricultural lime, refining of oil, the ceramic industries (including brick, tile, pottery, etc.), portland cement, and concrete aggregates, natural and fired.

Industries which appear to offer opportunity for initial development in Mississippi are the production of salt, rock wool, and drilling mud.

Mineral substances appearing deserving of further study toward industrial use are glass sand, lignite, carbon dioxide gases, S gases, Fe ores, glauconite, heavy minerals, clays for alumina extraction, tripoli, and chert.

The report is illustrated with photographs and maps showing distribution of plants in operation; it gives selected chemical analyses, and includes several pages of selected topical references.--Auth.

2-745. Akademiya Nauk Azerbaidzhanskoi SSR, Institut Geografii. MINERAL RESOURCES OF AZERBAIJAN: Internat. Geology Rev., v. 1, no. 12, p. 80-85, Dec. 1959.

The principal mineral resources of Azerbaijan are petroleum, Fe ore, and alunites. The principal mineral regions, their history of development, and present status is summarized.--M. Russell.

13. FUELS

See also: Geologic Maps 2-530, 2-532; Structural Geology 2-558; Stratigraphy 2-573, 2-574, 2-577, 2-578; Geophysics 2-646; Mineral Deposits 2-745.

2-746. Hiestand, Thomas C. DEPLETION: Geo-Times, v. 4, no. 5, p. 38, 45, Jan.-Feb. 1960.

Depletion is a reduction in capital assets equal to the value of the oil and gas at the reservoir level in the lease property. In 1917 the U.S. Supreme Court ruled that oil and gas in a producing lease are capital assets; thus depletion is a capital loss to the producer, both the working interest and royalty interest owners. In 1926, producers were permitted to classify as capital loss either 27.5%

of the total sales receipts for oil and gas sold from a lease property during a taxable year, or 50% of net amount computed by difference taken between the total sales receipts and total cost of operating the lease property during the taxable year, whichever is lesser. Geologists have the responsibility of determining whether the provisions are true in properly classifying the capital loss due to depletion of the producing lease property.--M. Russell.

2-747. Harrington, John W. PHILOSOPHY OF PETROLEUM EXPLORATION: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 2, p. 227-234, chart, 2 diags., Feb. 1960, 2 refs.

The problem of the exploration geologist is to predict accurately the state of nature at a concealed point within the earth. Management is committed to spend exploration money and has little choice but to accept the geologists' recommendations. They are the only people who have actually studied the data. Therefore the professional responsibility lies with the organization and analysis of information. Prediction requires an extension of knowledge from the known into the unknown areas. That is the trick. Two methods of increasing predictability are presented. One is concerned primarily with the sandstone reservoirs. Here the gross shapes of rock units are considered to be functions of the vectorial nature of the energy gradients present in the depositing currents. These vectorial directions can be deduced from the unda, clino, or fondo environmental position in which the rocks were deposited. The second method is of less general nature. It is concerned with predicting the loci of carbonate reef knolls from the available information of the submarine topography of deposition.

It is concluded that as the structural hunt in the unda beds with their ease of lateral predictability is brought to a close by the exhaustion of anticlinal possibilities the geologists will be forced to study the environment and topography of the clinoform. In this zone of unequal depositional rates, abrupt facies changes and few regional markers, the exploration tool will be one of logic. When economically feasible, drilling the first of a series of wildcat wells as a means of improving the distribution and quality of data will be a valid approach to later discovery.--Auth.

2-748. Johnson, Hamilton M. GEOLOGIST'S INTERPRETATION OF DRILLING MUD REQUIREMENTS: World Oil, v. 149, no. 6, p. 133-136, Nov. 1959; no. 7, p. 116-121, Dec. 1959, port., graph, 10 logs, 5 refs.

The electrical log is a most important tool in drilling for oil. Geological evaluation of logs must take account of complex fluids, various depths, temperatures, and pressures along with filtering, plastering, and fluid loss problems. Drilling fluids are either water base or oil base, should have an optimum MF ratio of about 5 and conductivity which will pass a suitable current from electrode to formation. Physical properties of the mud and its environment vary, but resistivity decreases with increase in temperature, salinity, and pH. Fresh-water phosphate mud is useful only in temperatures less than 180°F., while caustic-quebracho is satisfactory for higher temperatures. Using one or the other, accurate interpretations are possible in many areas. Salt-water muds used in areas of evaporites having very low resistivity and excellent conductivity distort the results with conventional logs; hence laterolog, microlog, and gamma ray combinations should be used.

The need for improving our oil search has brought intensive scientific applications to well logging. Ca-bearing and starchy fluids useful in deep drilling make low resistivity muds which will mask pay zones on conventional electrical logs, but they are useful in thick shales or areas of high pressures or water loss. Other than conventional logs should be used in these cases. For deeper drilling close to gage holes and for having mud of good resistivity with high gel strength, a Ca variation using gyp, calcium sulfate, is favored. Oil-emulsion (stable oil) muds reduce bit wear, torque, and caving, retain the same electrical character as water base muds, but often mask formation oil on the record. Oil base muds vary from those containing almost no water (2-5%) to the newer "inverted emulsion" muds with 20-70% water which are nonconductive so that induction and gamma ray logs must be run. Sodium silicate muds used for controlling high-pressure salt water and heaving shale have very low resistivity, minimum density of 12 lb., high fluid loss, and are very expensive. It is important to make the type selected fit the need.--K. M. Willson.

2-749. Dunlap, Henry F., John S. Bradley, and T. F. Moore. MARINE SEEP DETECTION - A NEW RECONNAISSANCE EXPLORATION METHOD: Geophysics, v. 25, no. 1, p. 275-282, 6 illus., 2 diags., table, Feb. 1960, 3 refs.

A number of major oil accumulations of the world are associated with oil or gas seeps. At the least, seeps prove the existence of mobile hydrocarbons in a basin. At the most, and when used with other geological and geophysical data, they can aid in locating exploratory wells.

An effective and inexpensive instrumental technique for locating gas seeps has been developed for use in water-covered areas. If a seep is present, some of the methane dissolves in the water as the gas bubbles rise to the surface. Currents spread this methane-enriched water into a long plume. A boat samples the water continuously, operating over a grid laid out at right angles to the current. The gas dissolved in the water is broken out of solution, and trace concentrations of methane detected using an infrared analyzer. This equipment has detected seeps at distances as great as 6 mi. A novel system of locating using navigational radar is used in carrying out the survey.

Several marine seeps surveys have been carried out using equipment mounted on various vessels ranging in size from a 14-ft. outboard powered skiff to a coastwise freighter. Under most circumstances, the cost of the survey is a few cents per acre. In new basins, the method promises to be of considerable value in localizing areas of interest for more expensive exploration methods.--Auth.

2-750. Aschenbrenner, Bert C., and Charles W. Achauer. MINIMUM CONDITIONS FOR MIGRATION OF OIL IN WATER-WET CARBONATE ROCKS: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 2, p. 235-243, 4 illus., 3 diags., 2 graphs, 2 tables, Feb. 1960, 14 refs.

The minimum conditions for migration of oil through water-wet carbonates are of great interest to geologists concerned with regional exploration problems. Oil can not migrate either under hydro-

static or hydrodynamic conditions unless the displacement pressure exceeds the entry pressure of the pore interconnections. Since the entry pressure is largely a function of pore size and configuration, thin sections of various carbonate rocks were studied in detail. One hundred pores and corresponding interconnections were measured, and 50 pore-throat configurations were analyzed and classified as to pore-space type. The pore-size measurements ranged from 0.02 mm. to 1.40 mm., with a logarithmic mean of 0.137 mm. The measurements of the interconnections ranged from 0.0003 mm. to 0.123 mm., with a logarithmic mean of 0.0163 mm. In the pore-space type most frequently observed, the interconnections between pores were constrictions formed by individual carbonate crystals or fragments projecting into the pore space.

The logarithmic mean values for pore and throat size were used together with representative average values for crude oil and brine to estimate the minimum conditions for migration of oil through water-wet carbonates. Under hydrostatic conditions, the product of the sine of the regional dip angle (θ) and the length of a continuous oil phase (L) must be greater than the critical height for buoyant rise (h) in order to move oil through water-wet carbonates, i.e., $\sin \theta L = h$, where h was calculated to be 231 cm. (7 1/2 ft.). Hence, the displacement pressure needed is 6 1/2 times that required for oil migration through average water-wet medium-coarse sandstone. Under hydrodynamic conditions, the interaction of permeability, porosity, viscosity, and flow rate of the water, and oil-phase length must produce a critical pressure gradient of 44,105 dynes/cm^2/L cm. in order to move oil through average carbonate rocks.

The following are tentative conclusions.

1) The dominant pore-space type influences considerably the minimum conditions for migration.

2) The average depositional dips of shelf-type carbonates are probably insufficient to cause large-scale migration under hydrostatic conditions, unless these dips are associated with hinge lines or are amplified by tectonic disturbances.

3) Even low rates of flow of water can initiate and sustain migration of short continuous oil phases.

4) In basins where both carbonates and sandstones act as carriers and reservoirs and where the dips are generally gentle, the regional concentration of oil prior to localized entrapment occurs farther downdip for the carbonates than for sandstones.

5) Exploration on a regional scale should take into account the differences in the minimum conditions for migration of oil which exist between carbonate reservoir rocks and porous and permeable sandstones.--Auth.

2-751. Chilingar, George V. EFFECT OF SEA WATER ON PROPERTIES OF LIQUID HYDROCARBONS: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 12, p. 2860-2861, table, Dec. 1959, 4 refs.

Laboratory tests, over a period of 1 year, indicate that salt water does not appreciably affect liquid hydrocarbons. The period of storage was too short for any definite conclusions.--I. M. Johnston.

2-752. Sokolov, V.A. POSSIBILITIES OF FORMATION AND MIGRATION OF OIL IN YOUNG SEDIMENTARY DEPOSITS. Translated by J.N. Hagg and C.A. Damman: Internat. Geology Rev., v. 1, no. 12, p. 62-65, table, Dec. 1959.

Hydrocarbons, extricable by organic solvents, were found to occur in Recent marine sediments. The age of deposits under investigation here was determined by C^{14} method to be from 9,000 to 14,000 years, approximately. The problem of oil formation in these sediments is discussed in relation to accumulation rate of sediments and subsequent exposure of deposited material to bacterial action. Results of research on composition of gases present in various Recent deposits, and on that of gases formed by bacterial action on certain organic substances, established that methane formation is not accompanied by formation of heavier hydrocarbon or gasoline-hydrocarbon fractions. Absence of C_3-C_{14} hydrocarbons (gasoline fractions) in Recent sediments, along with gaseous hydrocarbon fraction (characteristic of oil occurrence), indicates that oil formation processes do not occur in young sediments at shallow depth, but rather in sediments at considerably greater depth. Consideration of migrating oil as a possible sorption medium for the transport of light hydrocarbon fractions (on the assumption that the absence of oils in younger sediments may result from their sorption and removal by other media) lends further substance to this argument. Younger sediments, constituting a relatively low-temperature environment, are excellent sorption media and therefore are not conducive to oil migration.--D. D. Fisher.

2-753. DRILLING WAS FINE IN '59: Oil & Gas Jour., v. 58, no. 4, p. 193-209, 14 maps, Jan. 25, 1960.

A survey of exploration activities in 1959 under the following heads: Gulf Coast, Arkoma basin, Panhandle, Texas-New Mexico, S. Texas, Four Corners, Wyoming, Williston basin, eastern, Kentucky, Alaska-Arctic (Canada), California, Africa. A text map for each region illustrates the major points of interest.--N. Street.

2-754. DRIVE BEGUN TO PRODUCE TAR SANDS: Petroleum Week, v. 10, no. 2, p. 9-11, 3 illus., map, Jan. 15, 1959.

North American oil reserves, which are now about 37 billion barrels, may go up greatly if large-scale exploitation of the estimated 300-billion barrel Athabasca tar sands proves economical. A $3.5-million pilot plant and strip-mining installation in these tar sands has been in operation for 7 months at Mildred Lake, approximately 300 mi. N. and a little E. of Edmonton, Alberta. If this pilot operation is successful, the 4 operators, Imperial Oil Limited, Richfield Oil Corporation, Cities Service Athabasca Incorporated, and Royalite Oil Company, Limited, plan to expand the operations tremendously and to lay a pipeline to Edmonton where a processing plant will be built. The mineable tar sands are 150 to 200 ft. thick, are quite fine and friable, and are underlain by limestone. In the 50,000-acre lease presently being tested the overburden consists of 25 to 100 ft. of soil and glacial drift. In this lease alone the reserves are estimated to be 10 billion barrels plus. Mining is with an ingenious Krupp wheel excavator, 9 ft. in diameter and installed on a 20 1/2-ft. boom. The Athabasca sands actually yield a bitumen which through heating and hydrogenation can be converted into crude of approximately 35°API gravity. The origin of the tar sands is speculative. They probably represent an oil lake filled with wind-blown sand as the grains are quite rounded.--C. C. McFall.

2-755. Bell, Alfred H., Richard F. Mast, Margaret O. Oros, Carl W. Sherman, and Jacob Van Den Berg. PETROLEUM INDUSTRY IN ILLINOIS, 1958. PART I. OIL AND GAS DEVELOPMENTS. PART II. WATERFLOOD OPERATIONS: Illinois State Geol. Survey, Bull. 87, 117 p., 3 maps (2 in pocket), sec., 4 graphs, 17 tables, 1959.

Illinois produced 80,779,000 barrels of oil in 1958, an increase of 5% over the amount produced in 1957. Fifty-three percent of the production (42,923,000 barrels) was estimated to have resulted from secondary recovery by waterflooding in 1958, the first year that secondary oil has accounted for more than half of the state's annual oil production.

Forty-five percent of the 2,291 new holes drilled were completed as producing wells. Seven oil pools, 2 gas pools, 48 extensions to pools, and 14 new pay zones in existing pools were discovered in 1958. Five pools had extensive development during 1958. None of the 9 discovered appears to be significant.

During 1958 a total of 443 controlled secondary recovery projects were reported in operation in Illinois. The oil produced from these projects amounted to approximately 40,883,000 barrels, and an additional 2,040,000 barrels of oil was estimated to have been produced by dump flooding. At the end of 1958 the total cumulative waterflood oil produced in Illinois was 224,147,000 barrels.

Pressure maintenance projects added 1,200,000 barrels of oil to the state's production but that was not considered as secondary oil.

Reserves are estimated at 624.8 million barrels as of Jan. 1, 1959, 42.5 million barrels less than the estimate for Jan. 1, 1958.--Auth.

2-756. Reeves, Corwin C., Jr. A CLOSER LOOK AT LOVE COUNTY: Oil & Gas Jour., v. 58, no. 1, p. 116, 118, 120-121, Jan. 4, 1960; no. 2, p. 124-126, 129-130, Jan. 11, 1960, 2 maps, 4 secs., 2 tables.

Love County was considered one of the poorest areas of southern Oklahoma but reevaluation has followed the discoveries of SW. Enville, Love County. The NW.-SE.-trending Marietta syncline (Marietta-Sherman basin) is the dominant feature. It is conveniently divided into 4 depositional slices, the first being the early Paleozoics. Uninterrupted deposition continued up to the Silurian-Devonian or pre-Woodford erosional period. The second sedimentary unit is sandwiched between the pre-Woodford erosional surface and the lower Pennsylvanian-Wichita orogeny. The third unit includes most of the Pennsylvanian strata and the Deese formation of it has more oil-producing zones than any other in Love County. The fourth unit consists of strata deposited on the Arbuckle orogeny erosional surface. The Wichita-Criner Hills trend lies mostly in the N. in Carter County and is essentially composed of 3 NW.-trending anticlines, each separated from the other by NW.-trending faults.

Love County has few fields when compared to surrounding counties and it is possible to illustrate the features which have influenced the accumulation in the county by examining 3 fields. The Northeast Greenville produces from 4 horizons and aptly illustrates the type of trap associated with an anticlinal trend which has undergone secondary deformation. The Southwest Enville has as its major pay the basal Oil Creek sand; there is also production from several minor zones, the Sycamore being the most important. The Stockton field produces from the Witt and Stickton sands of Pennsylvanian age.

For future prospects the Marietta syncline with its innumerable overlapping Pennsylvanian sands is most inviting. The presence of pre-Pennsylvanian oil was proved long ago, and concentration should be on exploration by sedimentary analyses, rates of onlap, offlap, and strike overlap.--N. Street.

2-757. Wilpolt, Ralph H., and Douglas W. Marden. GEOLOGY AND OIL AND GAS POSSIBILITIES OF UPPER MISSISSIPPIAN ROCKS OF SOUTHWESTERN VIRGINIA, SOUTHERN WEST VIRGINIA, AND EASTERN KENTUCKY: U.S. Geol. Survey, Bull. 1072-K, p. 587-656, 7 maps (1 in pocket), chart, 2 secs. (in pocket), table, 1959, 36 refs.

The stratigraphy of the gas-producing formations of Late Mississippian age in southwestern Virginia and adjacent parts of southern West Virginia and eastern Kentucky was studied by measuring in detail surface sections exposed along a generally NE. line from the Cumberland Gap, in Virginia, to Bluefield, West Virginia, and along a roughly parallel line 15 to 25 mi. to the NW. from Pineville, Kentucky, to the Blowing Rock Gap, in Kentucky. The surface studies were supplemented by examination of samples from wells drilled for oil and gas. The rocks studied range from the top of the Maccrady shale to the base of the Pottsville formation, and include, from oldest to youngest, the Greenbrier limestone, the Bluefield formation, the Hinton formation, the Princeton sandstone, and the Bluestone formation. The stratigraphic classification used differs somewhat from previous classifications of these rocks, as is shown by a correlation chart. The formations all thicken from NW. to SE. toward the Appalachian geosyncline. The Greenbrier limestone, chiefly limestone and dolomite with some calcareous mudstone, ranges from 250 to 848 ft. in thickness; the Bluefield formation, principally calcareous shale with some limestone, siltstone, and sandstone, from 191 to about 1,950 ft.; the Hinton formation, principally red shale and siltstone but with a sandstone and limestone member and locally thin coal beds, from 288 to 1,683 ft.; the Princeton sandstone, from 0 to 240 ft.; and the Bluestone formation of interbedded shale, mudstone, siltstone, sandstone, limestone, and thin coal beds, from 300 to 1,015 ft. This sequence of formations contains several gas-producing sands; possibilities for gas production are believed to be excellent in the part of the area in which rocks of the Pottsville formation are present at the surface. Further production should be obtained from the Greenbrier limestone, from beds in the Bluefield and Hinton formations (the several Maxton sands of drillers), and the Princeton sandstone (Ravencliff sand of drillers). Data on drilled wells which were started before Dec. 1948 are included in the report. --Auth.

2-758. Kröger, Carl. PHYSICAL AND CHEMICAL PROPERTIES OF BITUMINOUS COAL CONSTITUENTS (MACERALS). Translated by Gilbert H. Cady: Internat. Geology Rev., v. 1, no. 11, p. 89-93, 13 diags., table, Nov. 1959.

Investigation of bituminous-coal macerals, accomplished through the Institut für Brennstoff Chemie (Fuel Chemistry Institute) of Aachen, [Germany], is summarized here. Coal from 5 Ruhr coal beds was processed to obtain pure macerals in quantities sufficient to study their individual structure and chemical composition. Vitrinite, micrinite, and exinite were recovered accordingly, and their chemical and physical properties studied; detailed,

graphical interpretation of these data has been included. Chemical composition is derived for vitrinite, exinite, micrinite, and fusinite individually. Chemical structure of the macerals is discussed in relation to aromatically bound C content. It has been possible thus far to determine maceral properties with respect to coalification rank as well as to indicate differentiation of these properties in macerals from the same coal bed.--D. D. Fisher.

2-759. Copeland, M.J. COALFIELDS, WEST HALF CUMBERLAND COUNTY, NOVA SCOTIA: Canada, Geol. Survey, Mem. 298, 89 p., 8 figs. (4 in pocket) incl. maps, secs., col. geol. map (Map 1070A, in pocket), scale 1:126,720, 1958, 41 refs.

The report is a concise picture of the stratigraphy and coal resources of the W. half of the Cumberland basin. Current coal production from this basin is about 750,000 short tons of bituminous coal. Detailed descriptions and analyses of the coal seams, maps showing the positions and thicknesses of the seams, and summarized data from boreholes and seam outcrops are given to assist planners in maintaining high production,

The coal seams occur in rocks of the Cumberland group, upper Carboniferous. This group includes 4 principal mapped facies named A, B, C, and D. The most significant fossil plants for correlation purposes are Asterophyllites equisetiformis, Boweria schatzlarensis, Zeilleria frenzli, Oligocarpa brongniarti, Neuropteris tenuifolia, Lepidodendron dichotomum, and L. wortheni. The Joggins-Chignecto coalfield and the Springhill coalfield are the areas of mining; 80% of production is from the latter. Analysis shows: coal from Joggins-Chignecto, ash about 15%, fixed C about 45%, volatile matter about 35%, moisture about 4%, S about 5%, heating value about 11,000 BTU's per pound; coal from Springhill, ash about 8%, fixed C about 60%, volatile matter about 30%, moisture about 1%, S about 1.5%, heating value about 13,000 BTU's per pound. Reserves are estimated at 63,754,000 net tons probable and 158,562,000 net tons possible. A geologic map is included, covering only the Carboniferous of the W. part of Cumberland County.--M. Russell.

2-760. Johnson, William D., Jr., and Robert P. Kunkel. THE SQUARE BUTTES COAL FIELD, OLIVER AND MERCER COUNTIES, NORTH DAKOTA: U.S. Geol. Survey, Bull. 1076, 91 p. 2 illus., 5 maps (2 in pocket, incl. geol. map, scale 1:48,000), chart, 4 secs. (in pocket), 6 tables, 1959, 48 refs.

The Square Buttes coal field comprises an area of about 720 sq. mi. in Oliver and Mercer counties in W.-central North Dakota. It is bounded on the E. and NE. by the Missouri River and is named for the prominent buttes that rise about 400 ft. above the western bank of the river. Center, the county seat of Oliver County, is near the middle of the field. The coal field, which is a broad gently rolling upland containing scattered areas of semibadlands, ranges in altitude from 1,640 ft. to about 2,420 ft.

Formations exposed in the Square Buttes area are the Cannonball and Fort Union formations of Paleocene age and the Golden Valley formation of Eocene age. The oldest formation, the marine Cannonball, crops out mainly in the SE. and is composed of about 400 ft. of shales and soft thin-bedded sandstones. The nonmarine Fort Union formation, which conformably overlies the Cannonball, is exposed over most of the area. It consists of about 520 ft. of sandstone, shale, siltstone, and clay and contains all the coal beds of commercial value. Only 69 ft. of the nonmarine Golden Valley formation, which conformably overlies the Fort Union, is discernible in the mapped area. The Golden Valley consists of silty shale, crossbedded sandstone, thin beds of lignite, and in its lower part has a conspicuous marker bed. Glacial deposits from the Iowan, Tazewell, and Mankato ice sheets of Wisconsin age cover about half the area.

Five levels of terraces of Pleistocene(?) and Recent age, ranging from 5 to 135 ft. above the river, occur in the Missouri River valley; 4 levels of stream terraces of the same age are present in the valley of Square Butte Creek; and terrace remnants occur along most of the other streams in the coal field. Other surficial materials of Recent age include alluvium, landslide debris, and intermittent pond deposits.

The Tertiary strata dip less than 1° in a northerly direction into the Williston basin. Minor flexures with less than 25 ft. of closure interrupt the gentle dip. The maximum structural relief is 150 ft. Two exploratory wells were drilled in eastern Oliver County in 1942 and 1952, but neither well yielded traces of oil or gas.

Coal reserves in the Square Buttes field are estimated to be 3 billion tons in beds 2 1/2 ft. or more thick. About 64% of the coal, all of which is of lignite rank, is in 4 beds: the Hagel, Otter Creek, Red Butte, and Kuether. In 1952, only 1 mine, which supplied local fuel needs, was in operation.--Auth.

14. ENGINEERING GEOLOGY

See also: Structural Geology 2-558.

2-761. Ambraseys, Nicholas N. A NOTE ON THE EFFECT OF SURFACE LOADING ON THE SHEAR RESPONSE OF OVERBURDENS: Jour. Geophys. Research, v. 65, no. 1, p. 363-366, 4 diags., 2 tables, Jan. 1960, 2 refs.

The solution to a problem which often arises in earthquake engineering is given briefly. The problem is to find the shear response characteristics of an elastic homogeneous overburden subject to a seismic base disturbance when its surface is uniformly loaded. An example is given in which shear and strains at the base and top, and the periods of the first 2 modes of free undamped oscillation are determined for an alluvial deposit 16 ft. thick.--D. B. Vitaliano (courtesy Geophysical Abstracts).

2-762. Wuerker, Rudolph G. THE SHEAR STRENGTH OF ROCKS: Mining Engineering, v. 11, no. 10, p. 1022-1026, 4 diags., 2 tables, Oct. 1959, 34 refs.

Recently available results of measurements of the tensile and comprehensive strength of rocks permit determination of shear strength by a simple graphical method. While most previous measurements of shear strength have been made by time-consuming and expensive triaxial tests, the U. S. Bureau of Reclamation has shown that the drawing of a straight line tangent from the tension circle to the compression

rcle in a Mohr's diagram can be used as a useful pproximation. Evaluated were 26 rocks and 1 sam- e of concrete. Shear strength and straight-line quation of Mohr's envelope of these rocks are com- ted and tabulated. While this procedure is to be ed with some precaution when determining proper- es of a specific rock, it is of great importance nen discussing the behavior of rocks in general and nen trying to find a unified theory for the failure of ittle materials. Shear strength is not stated as an dependent property. Its dependence upon compres- ve and tensile strength is shown graphically, based on an expansion of Mohr's theory. The influence confinement on the results of common tests and behavior of rock in drilling and blasting is inves- gated. Parameters are established for shear rength and for the slope of Mohr's envelope.--Auth.

-763. Pichler, Ernesto, and Francisco Barros de ampos. ROCK CHARACTERISTICS AT THE PAULO OWER PLANT: Am. Soc. Civil Engineers, Soil ech. & Found. Div., Jour., v. 85, no. SM4, pt. 1, 95-113, 6 illus., map, 2 charts, 8 diags., table, ug. 1959.

The Paulo Afonso Project on the Rio São Francisco the first underground project in Brazil. The con- uit system, the powerhouse, and the discharge ystem are located wholly in rock. To obtain infor- ation about the possible behavior after excavation the rock surrounding these structures, a number tests, "in situ" and in the laboratory, were exe- uted. This paper presents a description of these sts and their results together with an outline of e local geology.--Auth.

-764. U.S. Bureau of Reclamation. TECHNICAL ECORD OF DESIGN AND CONSTRUCTION. CA- HUMA DAM, CONSTRUCTED 1950-1953: 172 p., figs. incl. illus., maps, secs., logs, diags., aphs, 6 tables, Denver, Colorado, July 1959, 21 fs.

Cachuma Dam is located on the Santa Ynez River, mi. NW. of Santa Barbara, California. Bedrock the mid-Miocene Monterey formation, consisting thin-bedded siliceous, diatomaceous, and tuffa- eous shales and minor calcareous beds. Minor ragging, squeezing, and shearing accompany folding d minor faulting in the shale. Trend of folding is esterly, parallel to the river.

The dam is earthfill, has a spillway on the left utment, and a tunnel outlet through the left abut - ent. The dam abutment is 3,350 ft. long at the est and has a maximum structural height of 279 ft. ove the lowest foundation. The embankment is of ned construction with riprapped upstream slope, ntral impervious core, and pervious outer slopes. cutoff trench was excavated to satisfactory founda- n for the full length of the dam embankment, and e foundation was grouted. The crest is surfaced th 6 in. of gravel. The resultant Cachuma Reser- ir has a total capacity of 205,000 acre ft., of which e 34,000 acre ft. reserved for silt is estimated to adequate for at least 60 years. Total cost of the m is estimated at $13,878,431.

The 6 chapters are as follows: 1 Introduction - story, climate, project location, purpose and plan, general description of the dam, and a cost summa- ; 2) geology; 3) explorations and testing for em- nkment materials; 4) design - earth dam, spillway d outlet works, mechanical design, miscellaneous; contract administration; 6) construction - compre- hensive narrative of procedures; 7) reservoir clear- ing. Five appendices are included which cover costs, the possible effect of earthquakes and the elements of design dealing with earthquakes, and bibliography. --M. Russell.

2-765. U.S. Bureau of Reclamation. TECHNICAL RECORD OF DESIGN AND CONSTRUCTION. TECO- LOTE TUNNEL, CONSTRUCTED 1950-1956, CA- CHUMA PROJECT, CALIFORNIA: 21 illus., 2 maps, 2 secs., 17 diags., 5 tables, Denver, Colorado, Sept. 1959, 17 refs.

This technical record of design and construction of the Tecolote Tunnel is divided into 5 chapters. Chap. 1 discusses history and project plan and pre- sents a general description of the Cachuma project and a cost summary of the Tecolote Tunnel. Chap. 2 covers geology; Chap. 3 is devoted to discussions of the design of the various structures which comprise the tunnel; and Chap. 4 contains factual information on major construction contracts. A comprehensive narrative of the construction is included in Chap. 5. --From foreword.

Tecolote Tunnel was designed for the purpose of conveying water from the Cachuma Reservoir to the South Coast conduit through the Santa Ynez Mountain Range. It is a 7-ft.-diameter tunnel with free-flow except for an 800-ft. reach of pressure tunnel up- stream from the gate chamber. The inlet portal is approximately 3 mi. upstream from the Cachuma Dam at elevation 660 ft. and passes through the mountain range in a southeasterly direction for a distance of 6.4 mi., with a slope of 0.00025. The out- let portal is located at the upper end of the W. fork of Glenn Anne Canyon at elevation 652.86 ft., and about 10 mi. W. of Santa Barbara, California.

The geologic structure penetrated by the tunnel is essentially an E.-W.-trending anticline cut near the crest by the southerly dipping Santa Ynez fault. Surface observations above the tunnel show that the broad, crustal part of the anticline is cut by minor E.-W. to N. 80°E.-trending faults and is gently folded by an anticline and a syncline.--M. Russell.

2-766. Owen, Howard Q. GLACIERS ARE STILL MAKING TROUBLE FOR HIGHWAY ENGINEERS: Better Roads, v. 30, no. 1, p. 27-28, 2 illus., map, Jan. 1960,

This article deals with the glacial history of part of the Red River Valley in Minnesota. The geologic processes involved during glaciation are reviewed. These include deposition of deep layers of clay, loam, or gravel. Several sample drilling logs are given, neither of which reached bedrock.

The construction of a bridge on very tricky clay foundations is described. Reinforced concrete piers were set on piling driven 80 ft. below the bed of the river. Annual inspections were scheduled to watch for shifts and settling which might occur. In 1959, inspectors revealed that one pier had settled 2 1/4 in. and had shifted 12 in. to the W. A crew of 10 men, using a 400-ton jack, jacked the bridge into place in a week.

Another innovation was the placing of a bridge on rollers and a track to compensate for shifting banks without interfering with the position of the bridge.-- W. T. Parrott.

2-767. Turnbull, W. J., and Charles I. Mansur. INVESTIGATION OF UNDERSEEPAGE - MISSIS-

SIPPI RIVER LEVEES: Am. Soc. Civil Engineers, Soil Mech. & Found. Div., Jour., v. 85, no. SM4, pt. 1, p. 41-93, illus., map, 2 secs., 19 diags., 8 graphs, 6 tables, Aug. 1959, 16 refs.

Seepage and sand boils landward of Mississippi River levees have been a problem during major high waters. After the 1937 high water, the Mississippi River Commission initiated a general study of underseepage and various methods of its control. Its specific purposes were to develop a better understanding of the phenomena of seepage beneath levees and of factors influencing underseepage, to obtain information pertinent to analyses of underseepage, to develop and evaluate control methods, and to develop formulas and criteria for their design.

The studies reported herein include a compilation of past underseepage reports; exploration and geological studies of numerous sites where underseepage was a serious problem in 1937; installation of piezometers at selected sites to measure substratum pressures; field pumping tests to determine the permeability of the sand aquifer; theoretical, model, and prototype studies of relief wells, partial cutoffs, and landside berms for controlling underseepage; and observation and measurement of natural seepage during the 1950 high water.

From the theoretical, model, and prototype studies it was concluded that:

a) Sand boils and subsurface piping along the Mississippi River levees are the result of excess hydrostatic pressure and seepage through deep previous strata underlying the levees. The severity of underseepage, both excess hydrostatic pressure and seepage flow, is dependent upon the head on the levee, source of seepage, perviousness of substratum, and characteristics of the landside top stratum.

b) There is a definite correlation between surface geology and the location and occurrence of underseepage and sand boils.

c) Seepage flow and hydrostatic heads landward of a levee can be estimated from seepage formulas, and/or piezometric data, and a knowledge of riverward and landward foundation characteristics.

d) Removal of the natural top blanket riverward by borrow operations has aggravated the underseepage problem along Mississippi River levees. Except where clay several feet thick was left in place, the source of seepage was in the riverside borrow pits.

e) Underseepage can be controlled by properly designed and constructed landside seepage berms, relief wells, and riverside blankets.--Auth.

2-768. Winslow, Allen G., and Leonard A. Wood. RELATION OF LAND SUBSIDENCE TO GROUNDWATER WITHDRAWALS IN THE UPPER GULF COAST REGION, TEXAS: Mining Engineering, v. 11, no. 10, p. 1030-1034, 3 maps, 2 secs., diags., Oct. 1959, 7 refs.

Subsidence of the land surface has occurred in several areas of the upper Gulf Coast region of Texas and in most of these sectors appears related to removal of ground water. In the principal area, the vicinity of Houston and Galveston, heavy withdrawal of ground water from a series of unconsolidated sands interbedded with clays has caused regional land-surface subsidence. Most of the subsidence is attributed to compaction of clays and other fine-grained materials as the artesian pressure head is lowered in the water-producing sands. Rate of subsidence has been about 1 ft. for each 100 ft. of decline of pressure head, and recent releveling has shown no appreciable change in this rate. Subsidence in this region probably will continue indefinitely even if ground-water withdrawals are not increased, because the head in shallow sands will continue to decline as it adjusts to lower heads in the deeper sands.--Auth.

2-769. Baker, Robert F., and Robert Chieruzzi. REGIONAL CONCEPT OF LANDSLIDE OCCURRENCE: Natl. Research Council, Highway Research Board, Bull. 216 (Natl. Acad. Sci.- Natl. Research Council, Pub. 669), p. 1-16. map, diag., 9 tables, 1959, 19 refs.

The report covers the initial phases of a basic study of landslides. The long-range objective is the development or refinement of quantitative methods for analyzing the degree of stability of natural slopes. The underlying principle of the research is that the types of landslides that occur in a given geographic region are relatively limited, and the number of variables present in a given region will be reduced or the range of values limited. Under such an approach a greater possibility exists for the establishment of a comprehensive generalized approach.

The phase of the research reported in the current report covers the basic concepts and the efforts to use physiographic provinces of the United States as the basis for regional considerations. Case histories from the literature, from the files of the authors, and from the questionnaire received by the HRB Committee on Landslide Investigations were the source of data. The landslides were classified in accordance with the new system proposed by the HRB committee, and a summary is included of the types of landslides that occur within the several regions.

Possibilities of immediate use of the results are recognized. If the types of landslides that occur within a region are limited, the highway engineers in a specific area can learn more rapidly and accurately how to analyze and treat the landslides encountered. --Auth.

2-770. Hennes, Robert G., S.E. Hawkins, and E.L. McCoy. AN APPRAISAL OF MEASURES FOR IMPROVEMENT OF SLOPE STABILITY: Natl. Research Council, Highway Research Board, Bull. 216 (Natl. Acad. Sci.- Natl. Research Council, Pub. 669) p. 17-30, 30 figs. incl. diags., graphs, 1959, 3 refs.

Generally, attempts to increase the factor of safety on an earth slope involve either drainage or excavation. The object of drainage is a lowering of the water table, with an accompanying reduction in the magnitude of unfavorable forces. In the present paper several graphs are presented which enable the engineer to estimate the amount of drainage necessary to achieve a desired factor of safety. These graphs yield safety factors corresponding to various levels of water table in an earth mass where the failure plane would approximate a Swedish arc located in a clay bank underlain by a permeable stratum.

An alternative procedure improves stability by unloading the slope. It is shown that flattening the slope is much less effective than benching per unit of excavation. Graphs are presented which plot factor of safety against quantity of excavation for both benching and slope reduction. Both $\phi = 0$ and $\phi > 0$ cases are considered.--Auth.

2-771. LeClerc, Roger V., and Robert J. Hansen. COMPUTER SOLUTION OF SWEDISH SLIP CIRCLE

ANALYSIS FOR EMBANKMENT FOUNDATION STABILITY: Natl. Research Council, Highway Research Board, Bull. 216 (Natl. Acad. Sci.- Natl. Research Council, Pub. 669), p. 31-43, 5 charts, 3 diags., 1959, 4 refs.

Personnel of the Materials Laboratory and of the Computer Section of the Washington Dept. of Highways have developed a program for the IBM 650 magnetic drum data processing machine which will analyze a given foundation problem in a matter of minutes. At present the program will handle analyses of embankment stability where the foundation is composed of as many as 3 layers or strata of different material. Although the present program is restricted to homogeneous embankments, suitable modifications should enable it to handle any number of embankment or foundation materials if they are placed or occur in a known geometric pattern in the cross section.

The following data are necessary for the machine analysis: cohesion, angle of internal friction, and unit weight of the soils involved; initial slope to be analyzed; thickness of the foundation soil strata; height of embankment; and design safety factor.

The program may be used in 2 ways: 1) to investigate a given range of slopes, automatically advancing to the next flatter slope if the safety factor against failure is found to be less than the predetermined value; and 2) to investigate a range of slopes, in individual analyses for each slope.--Auth.

2-772. Bonilla, M.G. LANDSLIDES IN THE SAN FRANCISCO SOUTH QUADRANGLE, CALIFORNIA: U.S. Geol. Survey, Repts., Open-File Ser., [no. 500], 44 p., 3 illus., 2 maps (1 in pocket), profile, diag., 4 graphs, table, 1960, 10 refs.

Landslide conditions in the San Francisco South quadrangle may be considered representative of landslide conditions to be encountered as other parts of the California Coast Ranges become more densely populated. Climate is intermediate between the more humid region to the N. and the more arid region to the S. Most of the common Coast Range rock types are exposed in this quadrangle, and all but 3 of the landslide types in the Highway Research Board classification have been observed here.

Debris slides are by far the most common, accounting for 42% of all the landslides. Earthflows are next most common, 21% , excluding the earthflows that are part of the complex slides. Least common types are rock slide, block glide, mudflow, debris avalanche, and sand flow.

Slope debris and ravine fill was involved in the greatest number of landslides, about 35% . Landslides in the Merced formation were the next most common, but almost all of these landslides were in steep sea cliffs. The decreasing order of frequency of slides in other materials is as follows: sandstone and shale of the Franciscan formation, artificial fill, sheared rocks, serpentine, greenstone and chert of the Franciscan formation, and Colma formation. No slides were seen in metamorphics of the Franciscan formation. Several other rock units were not involved in sliding, probably because they are seldom exposed in steep slopes. These are Quaternary alluvium, beach deposits, sand dunes, marine terrace deposits, and bay mud. Damage to one marine installation, however, was probably due to failure in the bay mud.

Most of the landslides occurred on slopes of 25°, and almost as many occurred on slopes of 40°. The peak at 25° rather than at a higher slope is the result of the interaction of several factors, the most important of which are probably 1) the relative abundance of slopes of a given inclination; 2) the distribution of the most troublesome material on gentle to moderate slopes; and 3) the fact that infiltration of rainwater is less on steep slopes than on gentle slopes. Most of the landslides in the San Francisco South quadrangle are on W. and SW.-facing slopes. Most of the landslides on W.-facing slopes are on the long sea cliff.

If direction of slope influences the incidence of landslides, the cause is probably related to the moisture conditions at shallow depths in the soil; therefore debris slides, debris avalances, and earthflows, all of which typically involve surficial materials with a high water content, should be influenced most by direction of slope. Most shallow, wet landslides occur on SW.-facing slopes and fewest occur on NW.-facing slopes. Because the structural trend is NW. in this area, more slopes face NE. and SW. than face NW. and SE. ; a plot of landslide frequency should therefore be elongated in a NE.-SW. direction. However, more than twice as many landslides of the specified types occurred on SW. slopes as occurred on NE. slopes.

The western slopes of mountain ranges on the Pacific Coast receive more rainfall than the eastern slopes but the effect of small topographic features on total rainfall is not clear. Orographic lifting is of little importance in small topographic features. On small features, however, the trajectory of the raindrops may be important, as the amount of rain that falls can vary with the sine of the angle of incidence. Precipitation stations are not spaced closely enough in this area to show whether small-scale topographic features receive more rain on SW. than on NE. slopes.

Between periods of rainfall, transpiration, solar radiation, and wind act to remove moisture from the soil. Although vegetation removes moisture by transpiration, vegetation also increases infiltration of rainwater, and the net effect is not easily evaluated. Solar radiation is of course greater on southerly slopes, and in this area the prevailing winds are westerly so that the soil on southerly and westerly slopes should dry more rapidly, more frequently, and more deeply than the soil on other slopes. Cracks formed by drying of clayey soil reduce its shearing strength and permit rainwater to enter the soil. Intermittent drying of the soil might thus control the formation of shallow landslides, but field examination revealed only small and seemingly insignificant cracks. More facts are needed to explain the preponderance of landslides on southwesterly slopes.--From auth. summ.

15. MISCELLANEOUS

-773. Beiser, Arthur. OUR EARTH; THE PROPERTIES OF OUR PLANET, HOW THEY WERE DISCOVERED, AND HOW THEY CAME INTO BEING: 23 p., 9 illus., 21 figs., New York, E.P. Dutton, 959.

This is an account for the layman covering the dimensions of the earth, its position in the solar system, its composition and surface, the effects of the atmosphere and the tides, and terrestrial magnetism. Theories on the origin of the earth and solar

system are reviewed, including a discussion on the age of the earth and its probable end caused by swelling of the sun to a diameter as great as the orbit of Venus.--M. Russell.

Contents:
Dimensions of the World.
Solar System.
Within the Earth.
The Crust.
Time and Tide.
Terrestrial Magnetism.
Origin of the Earth.

2-774. Longsworth, Polly. EXPLORING CAVES: 175 p., illus., New York, Thomas Y. Crowell Co., 1959, 27 refs.

This is a popular account for young people of adventuring in caves. It describes how to look for caves, what to wear, what kind of equipment to use, and what rules to follow when exploring them. It includes sections on the formation of caves, description of peculiar features, animal life, and brief biographies of noted speleologists. A list of 60 caving terms and more than 130 commercial caves in 34 states is included.--M. Russell.

2-775. Eskola, Pentti. GEOLOGY IN FINLAND: GeoTimes, v. 4, no. 5, p. 8-9, 39-42, illus., Jan.-Feb. 1960.

In Finland, mining stimulated the earliest geologic research. In 1818 a government mining department was founded, geological mapping started in 1862 and the Geological Survey was founded in 1885. The rich Cu deposits at Outokumpu were found in 1910, their presence having been inferred 2 years earlier from the finding of a glacial boulder 55 km. away. Wilhelm Ramsay and J. J. Sederholm are credited with bringing geological research in Finland to a modern level. Much of the work done on the Finnish Precambrian centered around the problem of the base of the Bothnian formation. Much emphasis is given to the problem of the origin of granites and the absolute dating of rocks.--M. Russell.

2-776. Johnson, Henry S., Jr. BACKGROUND AND HISTORY OF "SOUTH CAROLINA GEOLOGICAL SURVEY": South Carolina, State Devel. Board, Div Geology, Geol. Notes, v 3, no 5, p. 5-6, Sept.-Oct. 1959.

The earliest state-sponsored geologic work in South Carolina was a one-year "Geological and Mineralogical Survey" made in 1825-1826 by Lardner Vanuxem. This was followed at irregular intervals by "surveys" by Edmund Ruffin in 1842, M. Tuomey in 1846, Oscar M. Lieber in 1856-1859, and Earle Sloan in 1904-1910. M. W. Twitchell, Stephen Taber, and L. L. Smith each served in succession from 1911 through 1956 as State Geologist as well as head of the Geology Dept. of the University of South Carolina. There was no continuing organization actively investigating the geology of South Carolina prior to 1957.

In June 1957 The State Development Board formed the Division of Geology with a staff of one full-time geologist and one secretary. In Aug. 1958 a second full-time staff geologist was employed. Additional geologists and assistants are employed part time to help conduct field and laboratory work in a continuing program of studying and appraising the geology and mineral resources of the state.--Auth.

2-777. Marsh, Owen T. A GEOLOGIC-PROFILE PLOTTER: Econ. Geology, v. 55, no. 1, p. 201-204, illus., diag., table, Jan.-Feb. 1960.

Design and uses are described of an easy-to-construct instrument that facilitates construction of profiles of land surfaces, geologic formations, or other features such as profiles of geophysical or geochemical anomalies. Response to data from users of the instrument indicates that it is both faster and more convenient than previous methods.--J. A. Chamberlain.

2-778. Moore, Raymond C. CAN AGI SURVIVE?: GeoTimes, v. 4, no. 5, p. 10-12, Jan.-Feb. 1960.

Few earth scientists are opposed to enhancement in prestige of their profession or to the objectives set forth to guide the American Geological Institute, but very many have not yet come to feel that such matters affect them personally. A way must be found for the profession as a whole to underwrite appropriate costs of advancing its collective interests through AGI. Equitably distributed support from the whole profession is demanded. Objectives of important actions in progress are 1) preparation of a new constitution and by-laws for more effective administration of an intersociety organization in the earth-science field; and 2) formulation of a sound program of financial support for this organization by the profession. We have come to a critical juncture. Our (AGI) survival depends on ourselves.--Auth.

2-779. AGI SPONSORS VISITING INTERNATIONAL SCIENTIST PROGRAM: GeoTimes, v. 4, no. 5, p. 18-19, 4 ports., Jan.-Feb. 1960.

Professors Paul Ramdohr, L. U. de Sitter, Augustin Lombard, and Stevenson Buchan will each make 8 one-week visits to college departments in the United States to lecture and discuss geological research. This program is sponsored by the American Geological Institute aided by a grant from the National Science Foundation.--M. Russell.

2-780. Kerr, Paul F. HENRY R. ALDRICH: GeoTimes, v. 4, no. 5, p. 14-16, 2 graphs, Jan.-Feb. 196

The career of Henry R. Aldrich is reviewed on the occasion of his coming retirement as Secretary of the Geological Society of America, a post he held from 1940 to the present.--M. Russell.

2-781. Blakely, Merle F. HOW GEOLOGISTS FEEL ABOUT REGISTRATION: Oil & Gas Jour., v. 58, no. 1, p. 52-54, 2 illus., Jan. 4, 1960.

Geologists are sharply split over the question of registration law. Some claim that registration would enhance the professional standing of geologists and others that it would open the door for governmen control. Four professional groups are studying the problem, these are: the American Association of Petroleum Geologists, the American Geological Institute, the Abilene Geological Society, and the Southwestern Federation of Geological Societies. Present poll-taking may be only the forerunner of sharp debates before the issue is settled.--N. Street.

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